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COMING SOON

Another in the series of articles on the finishing methods in common use for stainless steels.

A discussion of the value and utilization of voltage and current stabilization and control as applied thru plating rectifiers.

Helpful information on the properties and selection of suitable anodes for copper and brass plating.

Laboratory methods for control of electroplating operations and deposits are discussed in another of this interesting series.

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METAL FINISHING

DEVOTED EXCLUSIVELY TO METALLIC SURFACE TREATMENTS

VOLUME 46 • NUMBER 2 • FEBRUARY 1948

Two Bibles for Your Library

Continuing a custom which has been in existence for many years, FINISHING PUBLICATIONS will again publish a newer, larger, and more comprehensive edition of the GUIDEBOOK AND DIRECTORY for the METAL FINISHING INDUSTRIES. This 1948 edition should be ready for distribution about July 1st.

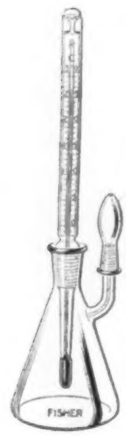
The 1948 GUIDEBOOK will not include the sections on ORGANIC FINISHING that were in the previous edition. This material has been supplemented by a great deal more information and data pertaining to the paint, lacquer, and enamel fields and will appear as the ORGANIC FINISHING GUIDEBOOK-DIRECTORY in place of the April issue. Early indications are that this manual will become every bit as useful and popular as the plating volume. Future plans are to publish this yearly.

An outstanding new feature of the 1948 GUIDEBOOK will be the addition of an extensive section on "Plating Plant Engineering". This section will contain articles written by prominent experts in the field, and will cover such important subjects as Health Hazards and Their Control, Waste Disposal Methods, Cost Methods, Control Equipment, Power and Wiring, Tanks and Linings, Floor Construction, Racks and Coatings, Plating Cycle Layout, Pumps, Filters and Auxiliary Equipment, and Ventilation and Air Conditioning.

In addition to this, the regular sections will be revised and enlarged to include the very latest information on each subject, so that users can continue to depend on this source for authoritative and practical help with their plating and finishing problems.

We are proud of the fact that the GUIDEBOOK and DIRECTORY is more familiarly referred to as the "bible" by platers and finishers everywhere, and deeply aware of the obligation to keep this fountain of knowledge reliable and complete.

We feel sure that the new edition will continue to maintain the same high standards as heretofore and will remain the biggest value in the finishing library.



Laboratory Tests and Equipment

By J. B. Mohler and H. J. Sedusky, *Research Chemists*

EVERY specialist works with tools that set his trade or profession apart from that of others. A metal shear, a test tube and a stethoscope are automatically associated with a tinner, a chemist and a doctor, respectively. However, the individual in each of these three fields may use a common instrument such as a saw. The design and application in each case would be different. In the first case it would be designed for cutting patterns from light gage sheet metal, the second would be a wide blade hack saw for sampling metals, the third a sturdy blade for cutting bone. Every specialist develops distinctive tools and adapts common tools to his own particular line of work.

Many tools are available for analysis, testing and control of plating baths and electrodeposits, the choice of which depends on the methods and tests to be performed and the meaning of the results obtained.

Tests such as throwing power, hardness and corrosion resistance are difficult to interpret. Each may have a definite value in the development of a new plating bath and yet be worthless in evaluation and control of production material. Tests such as thickness, adhesion, porosity and shelf life may be essential to production practice.

Plating is applied for a definite purpose or to meet a specification. In either case it must be done to measure-up by some test. The test selected naturally should be a measure of the desired property. Sometimes the measurement is simple, sometimes it is difficult and at times it is meaningless (whether it be simple or difficult).

The object of this paper is to point out special methods of testing and to indicate the limitations of each test.

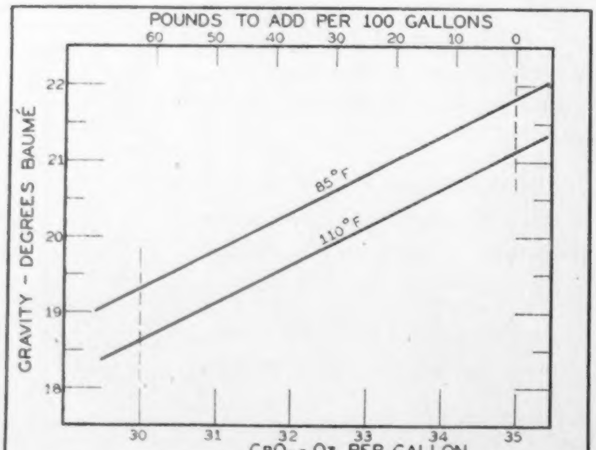


Figure 1. 22 degree Baumé chromic acid bath.

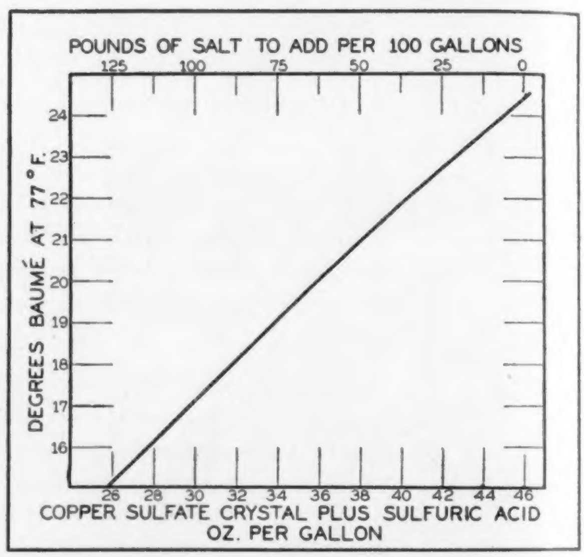


Figure 2. Gravity of an acid copper bath.

Gravity

The simplest test that can be carried out on a plating bath is to measure the specific gravity by means of a hydrometer. This test can be conducted in a matter of seconds. If the test were used for nothing more than to determine if a bath is thoroughly mixed, it would be worthwhile. However, much more can be learned from a gravity reading of a bath.

A plating bath is bound to have gravity limits. If a bath is made up with all chemical concentrations at the low limit, the resulting bath will certainly be of the minimum gravity allowable. If a bath is made up with all chemicals, plus the decomposition products, at a maximum, the resulting bath will be of the maximum gravity allowable. This bath then should always be within these limits; and a gravity

reading is an overall concentration check. It may tell if the bath is getting out of balance, or it may tell how rapidly decomposition products are building up (such as carbonate in a cyanide bath). It may occasionally detect the fact that the tank has sprung a leak. The value of gravity measurements in relation to solution composition control should not be overlooked. If an analysis can be eliminated by the use of a hydrometer then the hydrometer becomes a valuable tool.

Hydrometer readings have been used for analysis for many years. Sulfuric acid, for example, is known as "60" or "66" acid. This means that the sulfuric acid manufacturer guarantees sufficient acid concentration to test 60 or 66 degrees Baumé. Hydrochloric acid and many other chemicals are specified in the same manner. The gravity of these chemicals can be checked with a hydrometer and if they are later diluted with water they may be checked again to be sure the dilute acids are of the correct concentration. Data for all gravities can be obtained from a chemical handbook.

Gravities can be measured with a hydrometer calibrated in terms of specific gravity but Baumé gravity is much more widely used.

Occasionally only a small amount of solution is available to test. In a case like this, five or ten milliliters may be measured into a weighing bottle with a pipette and this volume of solution may be weighed. From the weight and volume, specific gravity is obtained. More accurate specific gravity determinations may be made with a special weighing bottle that contains a thermometer and holds an exact volume. This bottle is known as a "specific gravity bottle" and is used for accurate determination of specific gravity data. See illustration at beginning of article.

An ordinary Baumé hydrometer costing about $2.00 is quite accurate. It may be read to 0.1° Baumé and 0.1° Baumé is roughly equal to 0.1% solution or one gram per liter. A gravity reading is of sufficient accuracy that for a pure salt in solution it will compare favorably with a good analytical method. The nickel content of a nickel sulfate solution can be checked just about as accurately with a hydrometer as by the average chemical analysis. This is true because the nickel sulfate is a fairly pure salt. If such

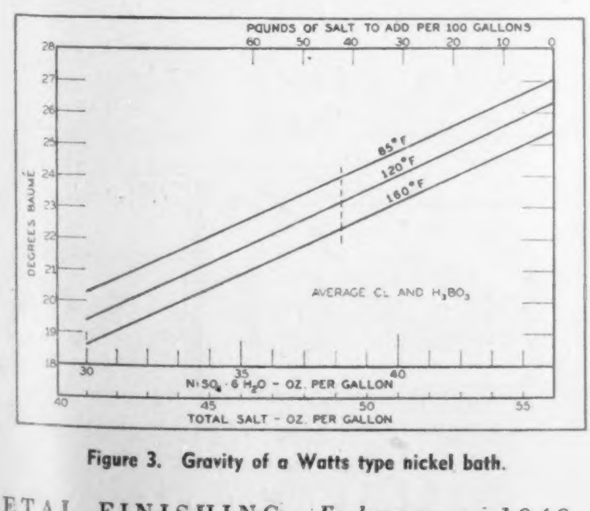


Figure 3. Gravity of a Watts type nickel bath.

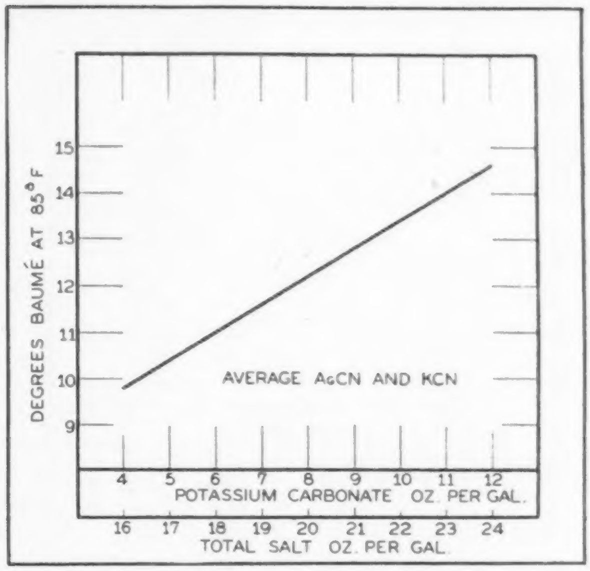


Figure 4. Gravity of a silver cyanide bath.

a method is used for analysis, a strong test solution should be prepared (about 200 grams per liter), the salt should be accurately weighed to within 0.1 gram. From the results obtained, the purity of the nickel sulfate can be calculated as follows:

$$\frac{\text{Weight of salt per liter (by gravity)}}{\text{Weight of salt}} \times 100 = \%\ \text{Purity}$$

In addition, the temperature of the solutions should be measured, since gravity changes appreciably with change in temperature. An increase in temperature of 10 degrees Fahrenheit will cause a lowering in gravity of about 0.3° Bé.

Gravity is widely used to control chromic acid baths and it will be worth our while to consider this in some detail.

Chromium Plating Gravity Readings

The chromic acid bath contains little else in addition to CrO_3. A small amount of sulfuric acid is added, some trivalent chromium is usually formed and certain impurities enter the bath during operation. These materials, however, only cause a minor increase in gravity. Since the bath may be operated with a wide variation in metal content, gravity is a satisfactory means for control.

If it is desired to operate a bath at 250 grams per liter (33.3 oz./gal.) all that is required is to hold the gravity in the vicinity of 21 to 22° Bé (at room temperature). For a bath of 400 grams per liter, (53.6 oz./gal.) 31 to 32° Bé will be sufficient.

It is easy for the plater to learn that a bath should operate at 22° Bé, or that it is permissible to operate the bath anywhere in the range of 20 to 22° Bé. This bath could then be referred to as a "22-degree" bath, just as we speak of "60-degree" acid.

The application of specific gravity in relation to plating baths can be extended further. A graph can be constructed that will enable the plater to interpret readings taken at any temperature. From the same graph the plater may learn the addition necessary to bring the bath up to gravity. Figure 1[2] shows such a graph for a "22-degree" bath.

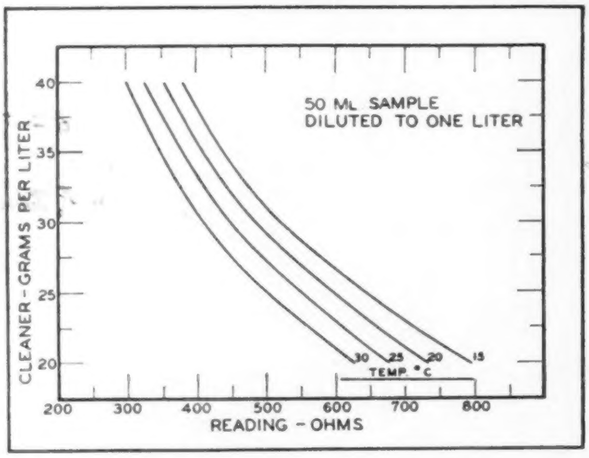


Figure 5. Conductivity control of a cleaner.

Two solid lines are given to show the gravity obtained at 85 and 100 degrees Fahrenheit. The effect of temperature can thus be taken into account. By use of this device the hydrometer can be dropped directly into the warm tank. Two dotted vertical lines define the gravity limits. A reverse scale at the top of the graph gives the pounds of CrO_3 to add for every 100 gallons of solution to bring the gravity up to the high limit.

The reverse scale may also be set-up in pounds to bring an entire tank up to gravity. Temperature may be in Centigrade and more lines may be used if desired. Gravity and concentration scales may be in other units. Grams per liter are practical units since one gram per liter equals one ounce per cubic foot.

Construct your own graph. The data required is: concentration versus gravity at a definite temperature and temperature versus gravity at definite concentrations. Tables No. 1 and No. 2 show data that may be used to construct your operating graph.

Table No. 1

22 Degree Chromic Acid Bath

Gravity of Chromic + 1% Sulfuric Acid

CrO_3 grams per liter	CrO_3 ounces per gallon	° Bé at 85° F.	° Bé at 110° F.
225	30	19.3	18.6
244	32.5	20.6	19.9
262	35	21.8	21.1

Table No. 2

32 Degree Chromic Acid Bath

Gravity of Chromic + 1% Sulfuric Acid

CrO_3 grams per liter	CrO_3 ounces per gallon	° Bé at 85° F.	° Bé at 110° F.
338	45	27.1	26.4
375	50	30.2	29.5
412	55	31.5	30.8
450	60	33.6	32.9

Tables No. 1 and No. 2 were constructed from several tables that were available for the gravity of chromic acid. Temperature corrections were made and one percent in gravity was added to allow for the sulfuric acid present. Checks between several available tables were fair.

Acid Copper Gravity Readings

The control of copper in an acid copper bath is interesting. Here the copper sulfate increases the gravity to the same extent as does the sulfuric acid.[1] The total concentration is determined by gravity. The sulfuric acid is determined by titration and the quantity obtained is subtracted from the total concentration to determine the copper salt content.

From available data the graph shown in Figure 2 was constructed. The bottom scale gives the total concentration as copper sulfate plus sulfuric acid. The reverse scale at the top of the graph shows the amount of copper sulfate crystal or sulfuric acid required to bring the bath up to gravity.

So far the examples cited have only shown how gravity may be used for simple applications. In connection with this, the following facts will bear repeating.

1. Gravity readings are rapid.
2. Gravity readings may be taken directly in the tank, (providing temperature is taken into account).
3. Gravity is an accurate indication of the total salt content.
4. Every bath has gravity limits.

Nickel Gravity Readings

If a gravity reading is taken on a nickel bath a measure of the total solids content is obtained. In a bright nickel bath this will consist of nickel sulfate, nickel chloride, boric acid, sulfuric acid and several brighteners. Each of these substances will increase the gravity, but each will increase it to a different extent. This would indicate that such a complex solution will not lend itself to gravity measurement. However, let us consider the limits on the following nickel bath:

	Limits oz./gal.
$NiSO_4.6H_2O$	35 to 45
$NiCl_2.6H_2O$	4 to 8
H_3BO_3	4 to 6
pH	3.5 to 4.5
Total Ni	8.8 to 12.0

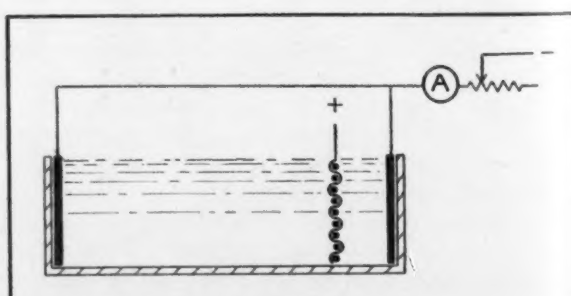


Figure 6. The Haring cell.

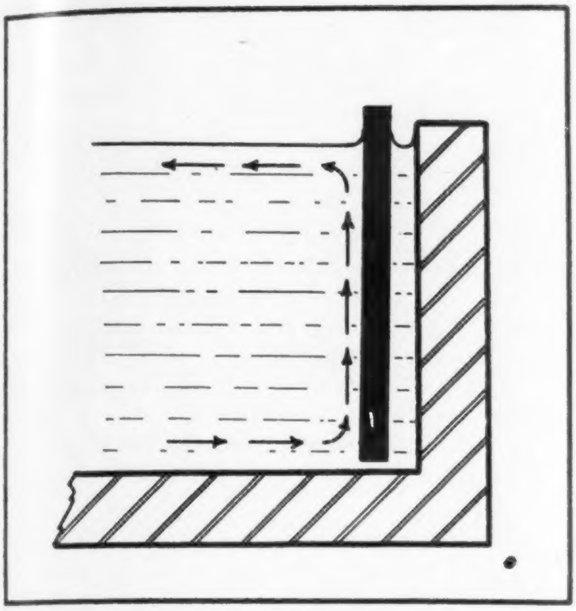


Figure 7. Errors in the Haring cell.

The limits for the total Ni are from 8.8 to 12.0 ounces per gallon. The bath will operate satisfactorily anywhere within this range. Now let us measure the gravities for the minimum and maximum solids content. The gravity is found to be from 21.2 to 28.3° Bé. But gravity is accurate and easy to control. So let us redefine the gravity limits from 24 to 27° Bé. Now the limits for total solids content are narrow enough so that the differences in gravity effect from the various solids will not place the bath outside the allowable limits. In fact the accumulation of impurities may still be tolerated as a gravity increase within these narrow limits.

This nickel bath may be analyzed for boric acid, pH, chloride and brightener. The nickel analysis may be eliminated since if these analyses are made, and gravity is controlled, the nickel will take care of itself. Figure 3 shows a control graph that may be used for this nickel bath.

TABLE No. 3

Gravity of Solutions

Range for $NiSO_4.6H_2O$: Average $NiCl_2.6H_2O$ and Average H_3BO_3

$NiSO_4.6H_2O$	35	40	45
$NiCl_2.6H_2O$	6	6	6
H_3BO_3	5	5	5
	—	—	—
Total Salt	46	51	56
°Bé at 85 °F.	22.5	24.8	27.0
°Bé at 120 °F.	21.7	24.0	26.3
°Bé at 160 °F.	20.9	23.1	25.4

Table No. 3 shows data that may be used to construct a graph for control of a nickel bath.

Cyanide Silver Gravity Readings

Now let us consider the following cyanide silver bath:

TABLE No. 4

	Oz./Gal.
$K\,Ag(CN)_2$	6 to 8
free KCN	4 to 6
K_2CO_3	4 to 12

A fresh bath will be made up with 4 ounces per gallon of potassium carbonate. As the bath is used the carbonate will gradually build up. If it eventually exceeds 12 ounces the plate will become rough and brittle. If an analysis is made for carbonate and free cyanide the silver may be determined by gravity. But when the carbonate becomes high such a method may result in an error of 1½ ounces. This is too large an error for silver or free cyanide control. If silver and free cyanide are determined the error will not be as large since these analyses are more accurate than the carbonate analysis. In addition the carbonate control is not too critical. A gravity reading may thus be used to control carbonate.

The following solutions were made up and the gravity was measured at 85° F.

TABLE No. 5

	Oz./Gal.	Oz./Gal.
$K\,Ag(CN)_2$	7	7
free KCN	5	5
K_2CO_3	4	12
	—	—
°Bé at 85° F.	9.8	14.6

The average values for silver and free cyanide were used. Notice that the silver cyanide complex has to be taken into account since the combined cyanide contributes to the gravity.

Figure 4 was constructed from the above two points.

If a graph is constructed for a silver bath it is best to measure a number of points and to measure concentrations other than the mean. The temperature effect should also be determined at several concentrations.

If a silver bath contains nitrate and caustic then analyses may be made for silver, free cyanide, caustic and carbonate. The nitrate may be controlled by gravity. This is time saving since nitrate is a difficult analysis. The method will be satisfactory because nitrate limits are wide.

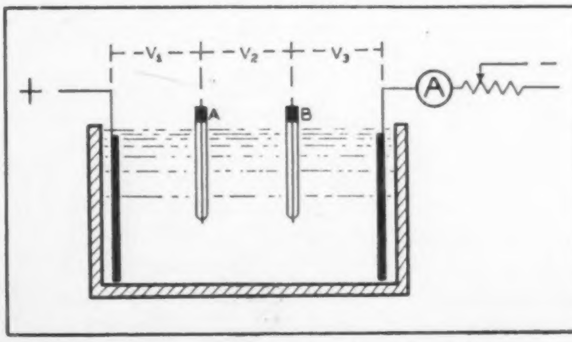


Figure 8. The measurement of polarization and resistivity.

Carbonate may be controlled on any cyanide bath by this method. If occasional analytical checks indicate that the analysis is not sufficiently accurate when carbonate is high, then the gravity will at least indicate when a carbonate analysis must be made.

A high efficiency copper cyanide bath in a steel tank will build up both in carbonate and ferrocyanide. Gravity may be difficult to interpret, but a knowledge of total solids will indicate the time when the bath should be cooled to crystallize excessive total solids.

Conductivity

A solution conductivity measurement is a rapid and accurate means of determining the concentration of acids, bases and salts.

Like gravity, conductivity is most accurate when applied to solutions of a single chemical. The measurement is therefore of little value applied to a plating bath, although it does measure the resistance of the electrolyte (it may be used to predict bath voltage). The measurement is of value in a cleaner, a pickle, or in rinse waters.

The conductivity cell consists of two electrodes, which are made of platinum or nickel, covered with finely divided platinum black. An alternating current is passed across the two electrodes and the resistance in ohms is read on a commercial instrument.

The large part of the current is carried across an electrolyte by the hydrogen ion or the hydroxyl ion. Therefore, if a solution contains an acid and a salt, conductivity will essentially be a measurement of the acid concentration. In a pickle solution the amount of iron present will have little effect on the conductivity. A reading may then be taken as a direct indication of the acid concentration. However, in some applications the pickle is used until the iron builds up and the acid becomes a minor constituent. If this is done, a gravity reading should be taken. From gravity and conductivity, both the iron and the acid may be estimated.

It is quite likely that an acid copper bath may be controlled by gravity and conductivity measurements.

The control of alkaline cleaners is a good illustration of how a conductivity meter and cell may be used to advantage.

In many cleaner applications the cleaning power is dependent on the hydroxyl ion concentration. This is particularly true of electrolytic cleaners where high pH means high conductivity. High conductivity means high current density and good cleaning power. Here is a case where we directly measure a factor that may be of prime importance to success of the bath.

A cleaner may be held within conductivity limits rather than chemical limits. These limits should be the same as those that give good cleaning power for a fresh cleaner. The cleaner may be operated by this means for a one week period. Conductivity limits may be maintained by addition of either cleaner or the most essential chemical. This scheme cannot be used for prolonged operation since build-up of carbonate will eventually upset conductivity as a measure of cleaning power.

Diluted samples give the most satisfactory results as the conductivity meter can be more sharply tuned. The increase of conductivity with temperature is approximately 2 percent per degree Centigrade, so temperature must be measured.

Figure No. 5 shows a control graph for control of a cleaner by means of a conductivity meter.

Throwing Power

Throwing power may be measured by the method of Haring and Blum.[2] The cell used in this test is commonly called the Haring cell. Two cathodes are placed at either end of the long, narrow cell. An anode is placed between so that the far cathode is five times the distance of the near cathode.

The following equation is used to express percent throwing power:

$$T = \left\{ \frac{5 - \frac{N}{F}}{5} \right\} \times 100$$

where: N = weight of deposit at the near cathode
F = weight of deposit at the far cathode

The measurement of throwing power is not a thing to be taken lightly. Haring and Blum made a detailed study of copper solutions and were able to draw mathematical conclusions. However, they were careful to point out that the quantitative results only apply as measured. For any practical application, conclusions from throwing power measurements are only qualitative. For instance, these authors found that dextrin decreased the throwing power of a copper sulfate bath at high current density, and increased the throwing power at low current density. Such information may be of value where a little better throwing power is needed. However, a few measurements are not enough. The current density, the shape of the piece, the cathode efficiency and cathode polarization should be considered.

A paper on throwing power was severely criticized by Charles Kasper.[3] He pointed out that the data from the "throwing-power box" is "confusing". An earlier criticism had been made by Walter Meyer.[4]

In addition to the fact that a throwing power

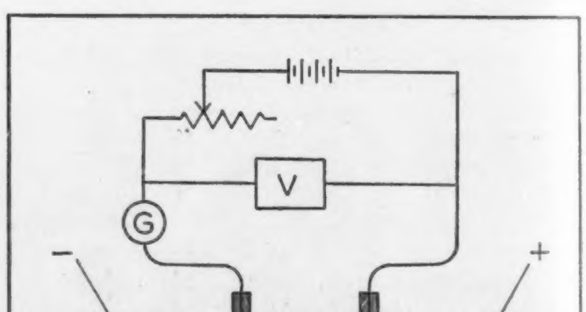


Figure 9. The measurement of current density.

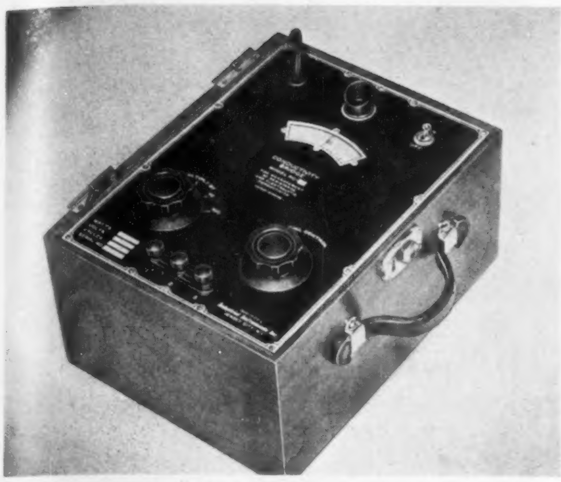


Fig. 10. Potentiometer used for current density measurements.

measurement is not a fundamental measurement it has been reported that results from one box may not compare with those "with a different box and under different conditions".[5]

The plater need not be too concerned with confusing results from a throwing power measurement in the Haring cell. It is enough to know that such results may only be used as an indication and to know that certain relationships have been established by Haring and Blum. Also it is possible to refer to the literature and study work such as that of W. A. Wesley and E. J. Roehl on the throwing power of nickel solutions.[6] Experiments of this nature are a good starting point if a definite problem in throwing power has to be worked out.

Finally it can be said that the approximate throwing power of all the common baths is known and a problem in metal distribution can usually be solved in some other manner than by attempting to change this property of the bath.

The Haring Cell

The Haring cell is useful for measurements other than throwing power. It is simply a rectangular box of value because uniform current density can be obtained in a vessel of this shape. For example: it can be used to advantage to measure cathode efficiency at a uniform current density.

Figure 7 shows a sketch of the Haring cell as it is used for a throwing power measurement.

The current density in the box of Figure 6 will be uniform through a cross section and it will be uniform over both cathodes.

The anode is a wire screen or a perforated plate of such a shape as will tend to polarize equally on each side.

The shape of the box is such that the flow of current is in straight lines from the anode to a cathode. Any condition that will tend to prevent uniform current over the cathode will lead to an error. To avoid such errors the cathode should fill the whole end of the box; and plating should not take place on the back of the cathode. If plating cannot be stopped on the back of the cathode by placing the cathode, tightly against the end of the box, then the back should be stopped off.

Small errors will result from effects near the cathode. Consider Figure 7. This sketch shows a cathode in one end of the cell. Capillarity causes the solution to rise on the cathode. Also there is a convection current set up due to a light layer formed by metal depletion. The magnitude of errors from these effects is not known but they may account for the fact that two different boxes give different results. If the cathode is completely immersed the capillary effect will be eliminated but it should not be immersed so far that current can concentrate on the upper edge.

The Haring cell is convenient for the study of conductivity and to determine anode polarization and cathode polarization.

Figure 8 shows a cell divided into three equal parts, with an anode at one end and a cathode at the other end. The voltages V_1, V_2 and V_3 may be measured. From the current and V_2 the conductivity can be determined. The anode polarization is V_1 minus V_2 and the cathode polarization is V_3 minus V_2. V_1 plus V_2 plus V_3 equals the cell voltage. The voltage may be measured with a potentiometer and the electrodes at A and B may be wire screens or they may be single wire electrodes.

A convenient instrument may be constructed as in Figure 9 to take the place of a potentiometer. In using this instrument, a potential difference exists between the two electrodes, so that it is necessary to adjust the circuit until there is no flow of current through the galvanometer. The current through the voltmeter, supplied by the external circuit, is such that the voltage across the meter is equal to the voltage across the electrodes.

The advantages of this instrument are that it is easy to construct and that it can be used for high cell resistances.

Current Density Meter

The instrument shown in Figure 10 (a potentiometer) may be used as a current density meter. It may be desirable to explore local current density near a point on a cathode. By use of two electrodes the voltage drop for any two points in an electrolyte can be measured. From the resistivity of the solution and the voltage drop the current can be calculated. The resistivity can be determined by use of the Haring cell.

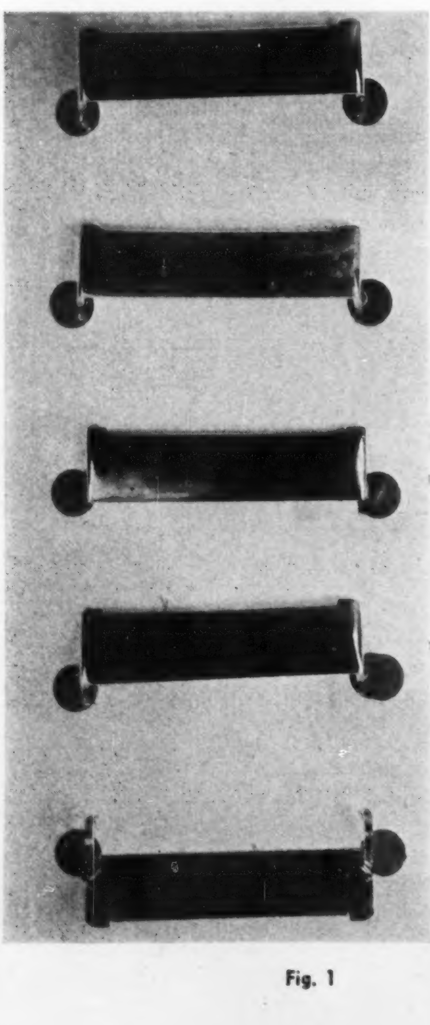
(To be continued next month)

Stripping of Rhodium Plating

By M. Shapiro, *Gillette Safety Razor Company, Boston, Mass.*

IN electroplating, as in any other manufacturing process, there are always a certain number of rejects due to various causes such as stains, pitting, roughness, and other miscellaneous reasons. In order to be able to reprocess this rejected work, it is necessary to have a stripping method that will remove the plated metal from the base metal without destroying or attacking said base metal severely. From a practical standpoint, the ideal method would completely remove the plated metal without pitting or otherwise altering the surface of the base metal, so that no additional refinishing would be required before replating. Unfortunately this is seldom possible.

This article will deal with two methods that have been developed to successfully remove rhodium plate from nickel-plated brass or copper.



A

B

C

D

E

Fig. 1

A

B

C

D

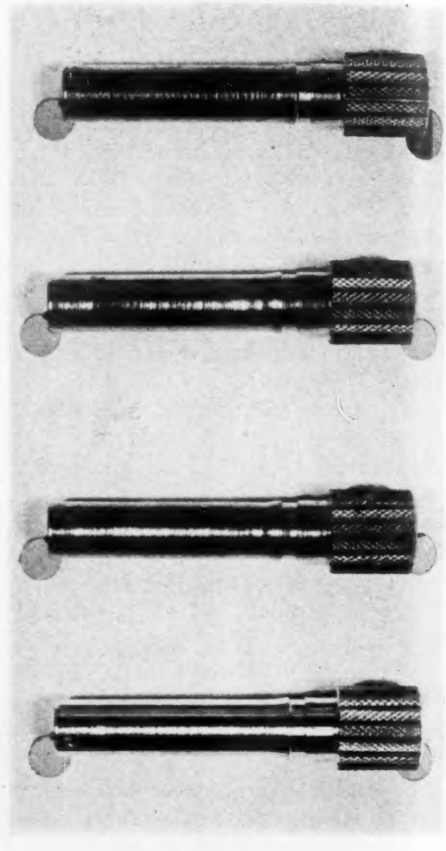


Fig. 2

The stripping of rhodium plate has always been difficult and often considered impossible without destroying the base metal, due to the properties of rhodium itself. Rhodium is insoluble in all of the known acids or combinations of acids that do not also attack nickel, brass, or copper. It cannot be stripped by a reverse cyanide solution as in the case of gold, another well known insoluble metal.

In looking about for a practical method for stripping rhodium from brass or copper, two facts assume the utmost importance. First, rhodium is rarely plated directly on the brass or copper, but an undercoat of nickel is usually plated on before the rhodium plate; and, second, the rhodium plate itself is usually a flash plate, in the vicinity of a few millionths of an inch in thickness. Therefore, while the rhodium plate itself may not be soluble enough to strip directly, it is, nevertheless, fairly porous at this thickness, and will allow a stripping medium to penetrate through the pores of

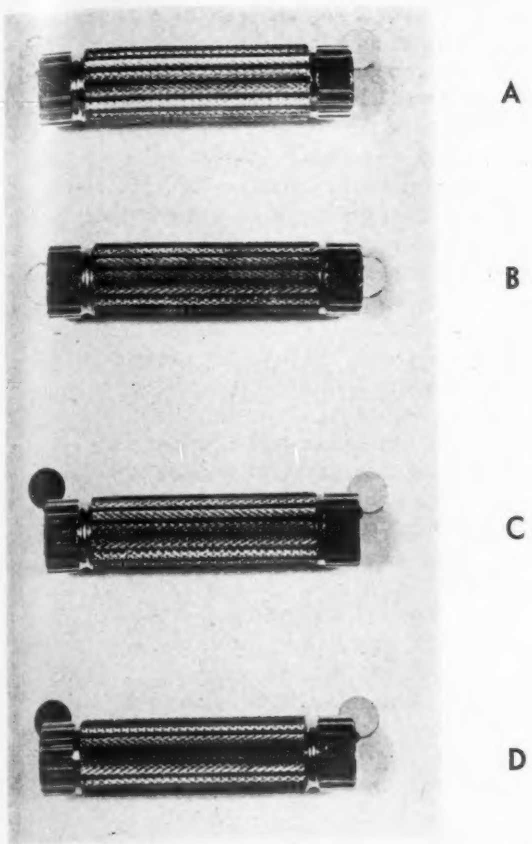


Fig. 3

the metal and attack the undercoating of nickel if the conditions are right and the article is left in the stripping solution for a long enough length of time.

Two stripping mediums are possible, depending on the finish of the article that is to be stripped, and the amount of time that is available for stripping.

On articles which can be refinished by polishing and buffing after stripping without spoiling tolerances, or on articles which have to be stripped in as short a period of time without regard for appearance, a dilute reverse current muriatic acid solution, at six volts, room temperature, will penetrate through the rhodium and strip the nickel from the base metal taking the rhodium along with it. This stripping action usually takes about five to ten minutes, depending on the thickness of the rhodium plate and the concentration of the muriatic acid. For a rhodium plate of three and one-half millionths thickness and a five per cent muriatic solution the stripping time was found to be about six minutes. It is necessary to agitate the work slightly to help in the stripping action. However, it must be emphasized that this process is very apt to pit and etch the base metal itself, especially if the article is left in the stripping solution too long for any reason. Addition of nickel chloride was tried as an inhibitor in concentrations from one to five percent, but the results did not warrant its use.

The concentration of the acid solution is not very critical and may vary from five to ten per cent by volume without effect on stripping time. An increase above ten per cent will decrease stripping time slightly but the etching effect on the base metal becomes quite severe.

The second stripping medium makes use of the same principle of removing the undercoat of nickel and allowing the rhodium to be carried off with it. However, this second method is very much slower and may take from one-half to one and one-half hours to complete the stripping, depending on the thickness of the rhodium plate. To compensate for the length of time required, this strip will leave the base metal of copper or brass smooth and fairly bright, and the article, after a bright dip and a light cut down and color operation, may be replated with nickel and rhodium.

The stripping solution is a reverse current, 55° Baume sulphuric acid solution, used heretofore to strip nickel itself. It may be mentioned that first attempts to strip rhodium by this method required about three hours stripping time and, in order to try to shorten the stripping time, the temperature, Baume, and the voltage were varied with the following results:

An increase in temperature from 70° F. to 100° F. decreased the stripping time from about three hours to about one and one-half hours. Over 100° F. and below 120° F., the stripping time was further decreased but the base metal acquired a mottled appearance. Over 120° F., nickel salts adhered to the parts being stripped in the form of a green scum, and left a pitted surface when this green scum was washed off with hot water. The stripping time was not decreased at these higher temperatures to any appreciable degree.

A decrease in Baume of the acid solution to 53° left the parts quite pitted although the stripping time was

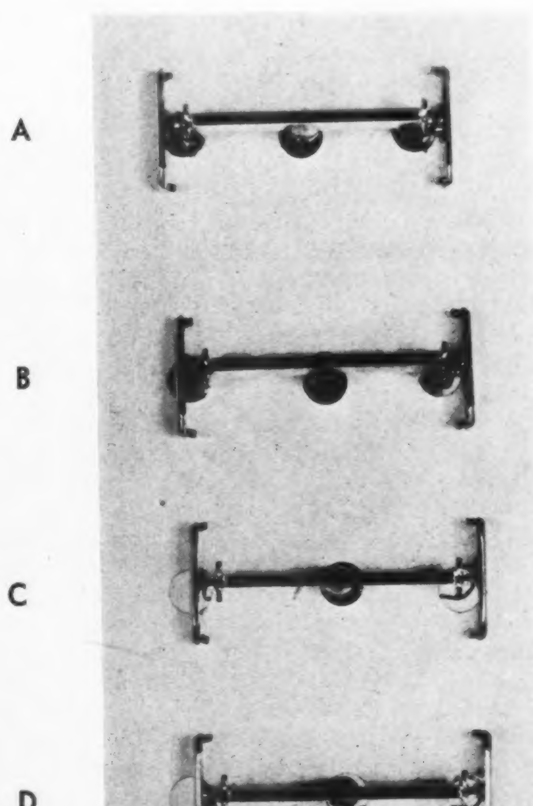
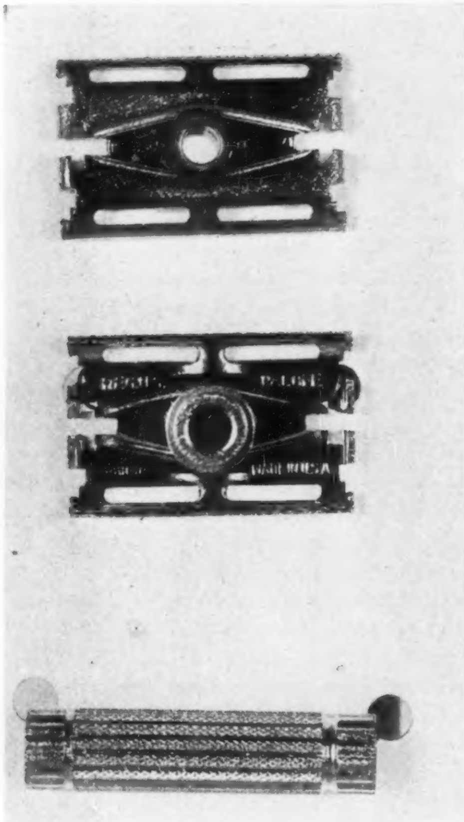


Fig. 4



A

B

C

Fig. 5

decreased. An increase in Baume over 57° increased the stripping time.

From the above results, the best conditions seemed to be:

Temperature 90° to 100° F.
Voltage 7 volts
Baume 55° to 56°

With these conditions, the stripping time of an article with an average thickness of three and one-half millionths of an inch of rhodium was found to be about fifty minutes.

In both of these stripping methods, it is necessary to have tight contacts between the article and the rack. Even a slightly loose contact will retard stripping time 100 to 200%. During the stripping process, a great deal of heat is generated due to the resistance of the sulphuric acid solution, the high currents used, and the length of stripping time. It is necessary, therefore, to have a cooling coil in the solution to maintain the correct temperature. Also, the racks may become quite hot for the same reasons, and should, therefore, be constructed of sufficient cross section to withstand these conditions.

The rhodium itself comes off in flakes, and, if allowed to settle, will fall to the bottom of the strip tank along with nickel salts in the form of a sludge. It may then be salvaged by scraping up, washing, and sending back to the refinery for salvage value. At the present time, the salvage value of rhodium is $112.00 an ounce.

The following illustrations show some of the results of a typical stripping operation.

Figure IA shows the half cap of a razor that is nickel and rhodium plated before stripping. Figure IB shows the cap just as it appears after stripping in the sulphuric acid, rinsing, and drying. Figure IC shows the appearance of the cap after stripping, rinsing, and bright dipping, and Figure ID shows the cap after a light cut down and color operation. It should be noticed that the surface of the cap is smooth and fairly bright even without bright dipping. This is important because the back of the cap (see Figure IE) receives only a bright dip before replating. It is not buffed or colored. Any pitting or etching on the surface of the back of the cap would be sufficient cause to scrap the part itself. Figures 2, 3, and 4 show the same sequence of operations or other parts of the razor. It is worth mentioning that the spider and stem assembly (Figure 4) is a soldered assembly, and that the stripping procedure does not injure or loosen the joints in any way. Figures I through 4 were all stripped in the sulphuric acid stripping solution at the optimum conditions mentioned previously.

Figure 5 shows the appearance of the guard and outer tube after stripping in a five per cent muriatic solution at 80° F., the time required being seven minutes. The parts have been bright dipped and, as can be seen, there is considerable etching of the surface.

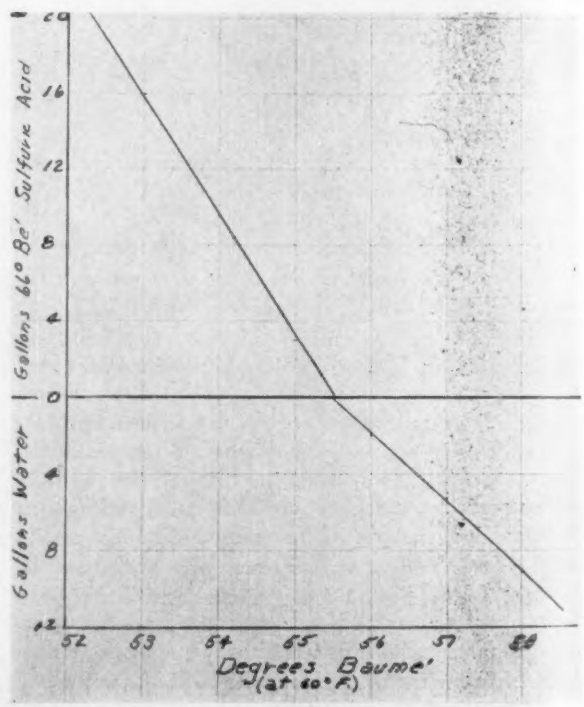


Fig. 6

Control

To control either of these two stripping solutions is a relatively simple procedure. The muriatic acid solution can easily be checked by titration against a standard tenth normal sodium hydroxide solution, using methyl orange as an indicator. The control of the sulphuric acid solution could also be done by titration against sodium hydroxide, but since the sulphuric acid is so concentrated, it is much easier to merely use a hydrometer and add water or 66 degree

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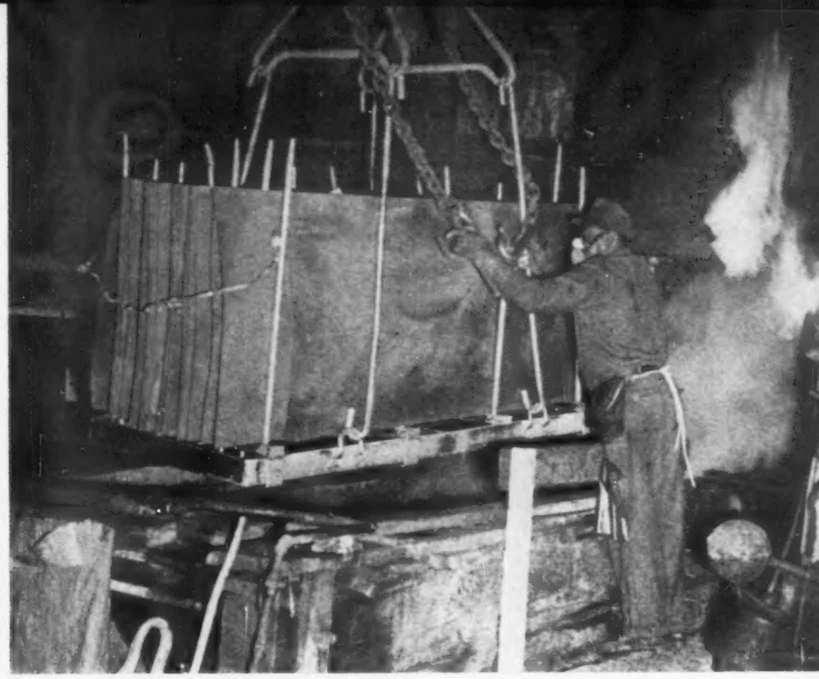


(*Courtesy Allegheny Ludlum Steel Corp.*)
Figure 1. Acid pickling stainless steel sheets for scale removal.

Fabricating and Finishing Stainless Steel—Part II

By Arthur P. Schulze, *Lakewood 7, Ohio*

This paper gives further information on surface treatments for stainless steel, covering scale removal by sandblasting, pickling, molten and aqueous alkali solutions and passivating. Formulas and methods used in the most modern processes are described.—Ed.

OF ALL the various requirements for the satisfactory application of stainless steels, surface preparation may be said to form one of the most essential. Since proper, adequate surface treatment is thus so important it deservedly demands the most careful consideration.

"Any extra efforts expended in producing a clean surface free from scale, iron contamination and other surface irregularities," says one primary producer, "will be reflected in trouble-free service and a long life of the fabricated article." Points up this authority in addition: Maximum corrosion resistance of these alloys will be obtained; fabrication and final finishing are facilitated.[1]

These and related factors, in turn, raise a good question: How can a scale-free surface be secured? Finding the right answer to that query is, in itself, frequently a problem of first-class magnitude. What light that current plant experience and shop practice shed in this connection comprises the main subject of this article, the second in a series on present-day stainless steel fabricating and finishing techniques.

Having reviewed, in a previous paper, the prime reasons why thorough removal of drawing, machining and spinning lubricants is regarded as so essential prior to annealing and also having examined emulsion-dipping, still-tank degreasing, electrocleaning and automatic machine washing methods and materials for handling this job, let us now turn our attention to another indispensable operation. This is scale removal.

Pickling and Descaling

The nature of the oxide or scale formation on stainless steels during heat treatment is determined by a number of factors. Among them are: alloy composition, furnace temperature, treatment time and composition of furnace atmospheres.[2] The lower alloy grades tend to oxidize or scale more at high temperatures than do the higher alloy types.[3]

Hard, stable and resistant, often containing high percentages of chromium oxides, these scales generally prove far more difficult to remove than scale formed on ordinary carbon steel. And because these deposits are tenacious and impervious to ordinary treatment, there is no single solution or one method of scale removal that will satisfactorily, or with equal efficiency, descale all the different types and grades of stainless steels under all heat treating conditions.[1,2,4]

Naturally, as is to be expected in view of these

factors, coupled with the additional observation that the thickness and density of forging and annealing scales vary across a wide range[4] owing to heating environment,[3] currently common scale-removing practice involves the use of mechanical methods, chemical procedures, or a combination of both,[2] depending upon character and severity of scale deposition and type of stainless steel in process. Sandblasting and tumbling are the two basic mechanical methods. Pickling in acid solutions is perhaps the chemical method in widest commercial use for scale removal today.

No special technique is required in sandblasting stainless steel. However, if parts are to be put in service with a sandblasted finish, cautions one authority, they should first be passivated as later described to remove iron particles and other extraneous material that tend to cause superficial rusting and discoloring of the surface. Shot-blasting parts with hardened steel grit is not recommended unless the blasted surface is entirely removed by grinding or machining.[3]

Although sandblasting is not the most desirable method of scale removal, it is in some cases the only way to effectively and economically remove scales of certain types. For example: Necessarily held at high temperatures for long periods of time, heavy sections of the chromium-nickel steels naturally develop a heavy, thick scale that would require an exceptionally long time to pickle. Sandblasting such sections is more efficient and economical than pickling. Again the straight chromium alloys, which are stack or box annealed and consequently slowly cooled, acquire a scaly condition which can only be removed by sandblasting. Yet good fabricating practice usually calls for supplementary pickling treatment to determine whether all the scale has been removed, not merely covered up.[1]

In chemical scale removal, customarily referred to as pickling, acid solutions may act on the scale in two ways. One is by direct, uniform attack in the nature of a dissolving action. The preferred scale removal method chemically, this seldom occurs to any extent in actual practice, particularly where stainless steels are concerned. In the other method . . . that is where the acid, while having very little dissolving effect on the scale, penetrates it by absorption and attacks the underlying metal surface . . . scale removal results from a combined undermining of the deposit and the lifting effect produced by hydrogen gas liberated during the attack of the acid on the metal.[2]

(*Courtesy Turco Products, Inc.*)
Figure 2. Adding inhibitor to pickling tank. Note structure of pickling line; tanks are lead-lined acid-brick and are sections of one long structure.

While the term "pickling" implies the removal of scale from metals in acid solutions, it is being broadened in scope among many metallurgists, chemists and finishing engineers to include molten alkalis and alkaline solutions containing additive reagents as these materials are enjoying increasing use to supplement acids in descaling stainless steels. Basically, the alkalis affect the scale only, exerting no effect on the parent metal.

Molten alkalis often incorporate additive chemicals which alter scale composition, making the accumulation more amenable to acid-attack. At the same time, these alkalis, used at relatively high temperatures, tend to soften the scale so that when the metal is water-quenched from the operating temperature, a shattering effect on the scale results due to the action between the water and the hot alkali.

Alkaline solutions of moderate concentrations and which contain strong oxidizing reagents are employed to change the composition of the scale deposit to a form more susceptible to attack in acid solutions. While some softening of the film is accomplished, it is not comparable to the softening action provided by the molten alkalis. The change in scale composition develops slowly, but these solutions prove materially beneficial in supplementing the acid solutions in securing complete, uniform scale removal. The alkaline solutions operate at comparatively low temperatures. They have proved economical over a period of time, and the necessary equipment is simple to install, easy to maintain.[2]

From this brief discussion it is obvious that since formulas vary so widely, it is, unquestionably, impossible and impractical to even attempt to make one standard descaling or specific pickling recommendation that will satisfactorily meet every single production requirement.[4] However, since the following methods have generally proved effective for removing most types of scale formed on stainless steels during heat-treating operations,[3] only minor operational changes or variations are usually required to successfully adapt one method or another for meeting the particular conditions presented by an individual case.[2]

During recent years, two-step techniques have become increasingly widespread to remove tight scales that develop upon slow cooling. One combination cycle, employed particularly with the straight chromium steels, is to first sandblast the surface and then complete the scale-removing job by immersion in a dual acid bath (10% nitric solution, with 3% muriatic addition) at a temperature of about 160° F.[5] For this pickling or passivating treatment, recommended to prevent staining or rusting, a 15% nitric acid solution at a temperature of from 140°-160° F. is also suggested.[1]

Where the heat-treating scale is heavy and the work permits, tumbling before pickling often proves time saving and economical. Tumbling removes much of the brittle scale and cracks the underneath layers, thus contributing substantially to their more uniform removal in the pickling baths.

Still another dual-treatment technique is to pickle in two operations . . . the first for softening and loosening the scale, the second for removing the deposit or for brightening the surface. Where the work is only scaled lightly, the preliminary scale-loosening treatment is often omitted. To minimize pitting of the metal, suitable inhibitors are added,[6] a practice that is now widely accepted as a standard, integral part of general acid-pickling procedure.[4]

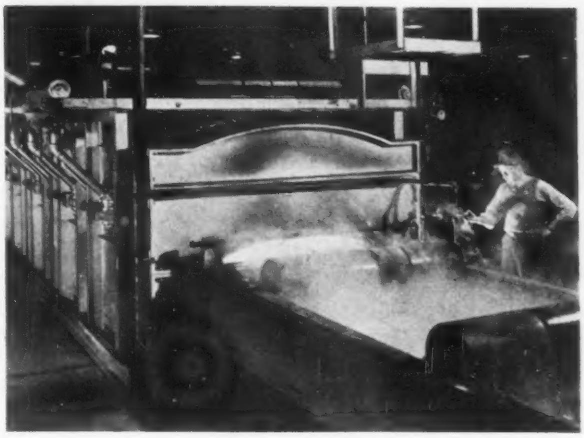
The chromium and chromium-nickel stainless steels may be pickled by 30-90 minute immersion (depending upon grade and condition of scale) in 10-50% muriatic acid solution containing a suitable inhibitor (temperature, 120°-140° F.), followed by 10-30 minute immersion at room temperature in a 6-8% solution of nitric acid containing 1½% hydrofluoric acid. When pickling the chrome-nickle grades, a 10% nitric solution can be used and bath temperature raised to 140°-160° F. following the muriatic treatment. Work is then removed and water-pressure-rinsed. If scale is not completely removed, the entire operation is repeated. Usually, a clean, white surface requiring very little scrubbing is obtained.[3,7]

Where muriatic acid is not available, a solution of 8-20% sulphuric acid at about 130°-160° F. may be employed. Time of treatment: 10-45 minutes, depending upon grade and condition of scale.[3,7] Another good pickle is a mixture of 6-8% sulphuric with 6-8% muriatic at 130°-140° F.[8,9] Since each of these acid baths serves as a preliminary pickle, it is followed by nitric-hydrofluoric treatment.

Still another dual-acid dip used in some plants consists of: (1) immersion of parts in inhibited 10-20% by volume sulphuric acid solution for 15-20 minutes at 160°-180° F., followed by (2) immersion in 10% by weight hydrofluoric acid for 8-15 minutes. Solution No. 2 is heated to 140°-160° F. for the chrome-nickel steels, while operation at room temperature proves satisfactory for the straight chromium steels.[2]

According to another equally outstanding authority, solutions of nitric and hydrofluoric acids are the most effective pickling reagents for the chromium-nickel grades. Depending on the oxide or scale present, solutions containing from 5-25% nitric acid and 1-4% hydrofluoric acid, by volume, are widely used. For light scales or oxides, a mixture containing 12-15% nitric and 1% hydrofluoric is satisfactory; for the heavier deposits, the ratio of nitric to hydrofluoric is lowered. Since nitric acid inhibits the action of hydrofluoric acid, the higher ratios of nitric acid do not result in as high a metal loss as lower ratios. Temperature of these solutions are maintained at 120°-140° F.[1]

In some instances, hydrofluoric acid is replaced by muriatic acid in these mixtures. Solutions in the order of 25% nitric—2% muriatic have been used satisfactorily. In using muriatic acid, the ratio of nitric to muriatic should not be less than 10 to 1.



(Courtesy Republic Steel Corp.)

Figure 3. Stainless steel strip emerging from normalizing furnace directly into pickle tank.

Otherwise, rapid attack occurs. Because they may pit the metal after they have been used for some time, solutions containing muriatic acid should be used with considerable care and caution.[1]

Other pickling formulas utilize acid-alkali combinations. The status of these methods, outlined below, should be investigated before prospective use to insure against violation of any vested patent interest:[2]

Method 1

1. Immerse in molten sodium hydroxide containing 20-40% by weight sodium nitrate at 850°-950° F. for 15 minutes. Water quench.
2. Immerse in 10-12% by volume sulphuric acid containing a good inhibiting agent at 160°-180° F. for 3-5 minutes. Remove and wash.
3. Immerse in 7% by weight nitric acid solution containing 1% by weight hydrofluoric acid for 6-10 minutes. Remove and thoroughly rinse with running water, preferably used under pressure. (Solution is heated to 160°-170° F. for chrome-nickel steels, while operating at room temperature will suffice for the straight chromium grades.)

Method 2

1. *Immerse in molten sodium hydroxide containing 1.5-2.5% sodium hydride at 750°-800° F. for 10-15 minutes. Water quench.
2. Immerse in 10-12% by volume sulphuric acid containing a good inhibitor at 160°-180° F. for 1-2 minutes. Remove and wash.
3. Immerse in 7% by weight nitric acid solution containing 1% by weight hydrofluoric acid for 5-10 minutes. (Solution is heated to 160°-170° F. for chrome-nickel grades, while operating at room temperature will suffice for straight chromium steels.) Remove and pressure-rinse with water.

Method 3

1. Immerse in 10-12% by volume sulphuric acid solution (inhibited properly) at 160°-180° F. for 5-7 minutes. Remove and wash.
2. Immerse in 12-14% by weight caustic (sodium hydroxide) solution containing 5-6% by weight

* Patent rights granted to the E. I. du Pont de Nemours & Co., Inc.

potassium permanganate at 170°-180° F. for 20-30 minutes. Remove and wash.

3. Re-immerse in original acid bath for 3-5 minutes. Remove and rinse.
4. Immerse in 7% by weight nitric acid solution containing 1% by weight hydrofluoric acid for 8-12 minutes. (Bath is heated to 160°-170° F. for the chromium-nickel steels, while operating at room temperature will suffice for the straight chrome grades.) Remove and rinse thoroughly with running water, preferably used under pressure.

METHOD 4

1. Immerse in 10-12% by volume sulphuric acid solution containing 2-4% by weight sodium chloride (with a good commercial inhibitor added) at 150°-170° F. for 10-15 minutes. Remove and wash.
2. Immerse in 10% by weight nitric acid solution containing 2% by weight hydrofluoric acid for 8-15 minutes. (For chrome-nickel grades, solution is maintained at 140°-160° F.; for the straight chromium steels, it is operated at room temperature.) Remove and rinse thoroughly with running water, preferably under pressure.

METHOD 5

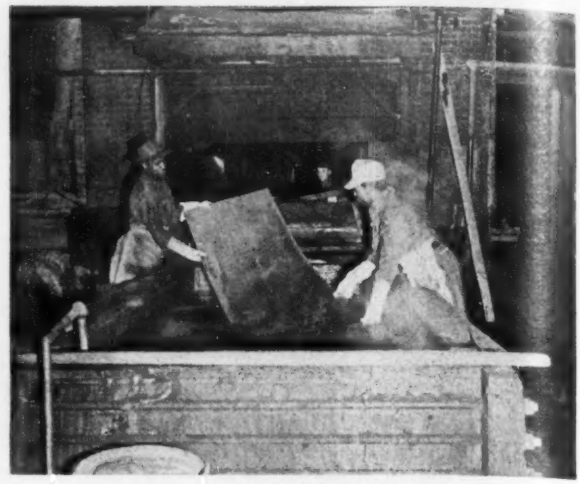
1. Immerse in 10-12% by volume sulphuric acid solution containing approximately 5% by weight ferric sulphate for 15-20 minutes at 160°-180° F. Remove and wash.
2. Immerse in 10% by weight nitric acid solution containing 2% by weight hydrofluoric acid for 8-15 minutes. (This method is suitable for chrome-nickel grades only. Solution is maintained at 140°-160°.)

In certain cases, the scale on stainless steels are exceedingly difficult to remove by normal pickling procedures. The extreme corrosion resistance of certain grades makes the removal of tenacious scale a lengthy process.[3] In such instances, the work is removed from the pickle bath and scrubbed with a stainless wire brush to loosen the scale, and then parts are repickled.[5]

A notable advance in ridding stainless steels of extremely difficult-to-remove scales has been made with the development of a new method,† and first put into large-scale commercial operation by the Rustless Iron and Steel Division of the American Rolling Mill Company.

This process, outlined previously under "Method 2" is based on scale reduction by sodium hydride. It consists of submersing the work in a fused caustic soda bath containing from 1.5 to 2.5% sodium hydride, which is produced by reacting sodium and hydrogen in reaction chambers located in the bath. When the scale is reduced, the work is removed from the bath and water-quenched. A final treatment completes the operation. Time normally required for

† Sodium Hydride Descaling Process patented by E. I. du Pont de Nemours & Co., Inc.



(*Courtesy Allegheny Ludlum Steel Corp.*)
Figure 4. Tank installation for passivating stainless sheet by hand.

pickling is substantially shortened. There is no attack on the base metal while the work is submersed in the sodium hydride bath.

Although the process has been primarily employed in continuously-operating volume-basis units or installations, its intermittent use is practical for smaller batch-type operations. And while patented, it is obtainable for laboratory or commercial application in the United States, free of license or royalty.[3]

Certain special supplementary notes on pickling are worthy of inclusion in this discussion. Pickling tanks employed are governed by the type of bath used. One authority makes these recommendations:[2] For sulphuric acid solutions—acid-resistant brick, lead-lined steel or wood tanks, glass, wood coated with a good grade of asphalt paint; for nitric-hydrofluoric acid mixtures—carbon brick lined tanks, wood, concrete coated with a good grade of asphalt paint; for alkalis and alkaline solutions—steel tanks.

Another prominent producer points out in this connection that pickling tanks which have proved satisfactory for nitric acid solutions include those made from certain chrome-nickel alloys or those of rubber or brick-lined construction. When hydrofluoric acid is present, however, carbon brick with proper cementing material should be used in pickling tank construction.[1]

In pickling the hardenable stainless steels, the high carbon grades never should be pickled in the hardened condition. Stress-relieving after hardening and before pickling is essential to prevent pickling cracks. Care also should be exercised in pickling these grades in the fully annealed condition. Unlike other stainless alloys, they are attacked in this condition by nitric acid and the surface of annealed parts may be roughened by over-exposure to this acid.[3]

Hydrogen embrittlement through exposure of stainless steels to reducing acids, such as muriatic, hydrofluoric and sulphuric acids, generally does not pose a problem with most stainless steels. The austenitic chromium-nickel and ferritic straight chromium steels are, apparently, not susceptible. The hardenable grades of the straight chromium hardenable group in

the fully annealed condition may sometimes be embrittled. With its high carbon content, one particular grade is also sensitive in the annealed condition, but embrittlement may be overcome by baking at 200°-600° F., preferably in steam.[3]

Passivating—Immunizing

In shearing, bending, drawing, rolling and similar forming operations where stainless sheet comes in close contact with and probably abraded by steel dies, some of the iron may become embedded in the surface. If not removed, this may show, under proper atmospheric or other conditions, a yellowish discoloration in such areas.[8,9] This is removed by passivation, or "immunization," as it is occasionally termed, a step in processing that should be employed after any pickling operation on stainless steel.[6]

Why passivation is universally recommended to supplement pickling may be explained in this way:

Stainless steels resist attack under various corrosive conditions through the medium of naturally formed oxide films, but the corrosion-resistance properties provided by these films are greatly dependent on the condition of the film itself. Should it be weakened owing to the presence of scale, heavy grease, oil, or other embedded foreign substances, premature failures may develop under environments where the steels, normally, would offer permanent resistance. If surfaces are in chemically-clean condition—free of all scale, grease and oil or metallic surface contaminates—these protective oxide films form naturally, completely, under atmospheric conditions.

In many cases, previously described cleaning methods are satisfactory, but in other instances, foreign substances are present upon which the solutions mentioned have no effect. Under such circumstances, a more drastic cleaning solution, a strong oxidizing agent, is called for to remove these contaminates and therefore to heal, fortify or "seal in" the natural passive film on stainless. The treatment is intended to enhance or insure maximum corrosion resistance.[2,3]

(Courtesy American Rolling Mill Co.)
Figure 5. Figure-8 shaped stainless bar, which has been pickled for scale removal then passivated.

Of these oxidizing chemicals, nitric acid, which rapidly attacks most other metals, has little or no effect on stainless steels,[2] and has proved the most efficient.[3] The practice of cleaning stainless steel parts in nitric acids, therefore, is referred to as "passivation" or "immunizing", since passivation demands virtually complete resistance of the stainless steels to this highly corrosive medium. Essential purpose of this treatment is to obtain as nearly as possible a chemically-clean surface,[2] restoring its stainless character through the formation of a passive oxide film.[5]

Nitric-acid-cleaning of stainless steels is used as a finishing operation. Therefore, if the passivating treatment is to be fully effective, all scale, grease, oil, drawing compounds, forming and machining lubricants and other similar foreign accumulations should be removed by vapor degreasing, alkaline cleaning or other previously outlined methods to prevent unnecessary contamination of the passivating solution.

Unlike pickling practices, passivating procedures have become highly standardized, with the result that formulas do not vary across such a wide range as is the case with acid pickles.

Passivation of stainless sheets may be conducted satisfactorily by immersing the finished formed or stamped article, after being thoroughly degreased and cleaned, in 20-40% by volume solution of nitric acid at 120°-140° F. for 15-60 minutes. Treatment time depends, of course, on previous finishing operations and surface condition of the work.[2,3,10]

A widely-used modification of this particular formula is: Immersion of parts in solution of 25% nitric acid at 120° F. for about 20-30 minutes.[6,9] The nitric acid removes all iron contamination without attacking the surface. If the product is to be polished, this nitric acid treatment is not necessary, as grinding and polishing remove the minute amount of iron present. For outside exposure, however, a final passivation treatment in nitric acid is suggested to develop a uniform surface condition.[7,9]

Under 20% by volume the nitric acid loses some of its capacity as a cleaning agent. Relatively weak solutions develop a slight surface etching. Over 40% by volume, there is a possibility that the iron particles acquired during processing will not be dissolved.[2]

When passivating highly polished parts of all grades, immersion of work in a solution containing 18-22% by weight nitric acid to which ½-2½% sodium dichromate has been added at 110°-120° F. for 15-30 minutes, is recommended to prevent surface-clouding.[2,3] After any passivating bath, treated parts are thoroughly rinsed,[5] preferably in clean running water, to completely remove any trace of acid.[2,3]

Immunizing by immersion is limited, of course, by shape and size of product. Naturally, this method is not practical for large objects or assemblies. However, for special severe requirements, application by swabbing is suitable. Where electropolishing is utilized as a finishing operation, subsequent passivation in nitric acid does not, it has been found, present

any additional advantages, since electropolishing develops a chemically clean surface.[2]

A quick dip or brief washing of work with relatively dilute nitric acid solutions (in the order of 15% by volume) does not constitute a true or proper passivating treatment, asserts one eminent authority. Conceding that such treatments are advantageous and encouraging their use because they remove metallic surface contaminates and foreign substances adhering to parts due to contact with drawing dies and machining tools, this particular authority advances this explanation to prove and support his assertion:[1]

"In order properly to passivate the surface of stainless steel to such an extent as to increase its resistance to general solution in corroding media that would under normal conditions cause solution of the metal, a more effective treatment must be applied. This treatment would depend on the corroding media. For example, the solubility of stainless steel in hot sulphuric acid can be appreciably reduced over a considerable period by boiling it in 50% nitric acid for aproximately one hour. A boiling 3%-5% solution of sodium bichromate will accomplish the same results but requires a 48 hour treatment. On the other hand, a 30 minute treatment at 140° F. in an aqueous solution of 4% hydrofluoric acid and 4% chromic acid increases the resistance of stainless steel to localized attack in solutions containing chloride ions. Such treatments are truly passivating treatments. However, it should be pointed out that passivating treatments are not permanent and reactivation of the surface can occur as a result of any condition that destroys the film such as bending, scratching, immersion in acid solutions into which nascent hydrogen is evolved, or a sufficiently long immersion in reducing solutions."

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STRIPPING OF RHODIUM PLATING

(*Concluded from page* 58)

sulphuric acid, depending on the Baume. The ordinary 0-72 degree Baume hydrometer may be used for this purpose, but for more accurate control, a 50-60 degree hydrometer should be used. For convenience, Figure 6 shows a graph on which Baume is plotted against the addition of water and 66° sulphuric acid. All that is necessary is to obtain the Baume at 60° F. of the sulphuric acid stripping solution, consult the graph and determine the amount of addition. For Baume less than 55.5°, concentrated sulphuric acid will be added and for Baume greater than 55.5°, water must be added. This graph is made for a 100 gallon tank and for different sized tanks, a correction should be made.

It is sometimes necessary to remove work from the stripping tank, and rinse to see if stripping is complete. If this is done, the wet articles should not be placed back on the anode bar without rinsing first in the stripping solution itself. It is necessary to remove all water from the surface of the articles, and failure to do so, will result in severely pitted and etched work. It should also be mentioned that the addition of water to a concentrate sulphuric acid solution generates a great deal of heat and caution should be used in the making of any additions, and especially the addition of water.

An easy way to determine if the stripping is complete, is to observe the rate of gassing. A rapid rate signifies that the stripping is far from complete. A slow rate of gassing or no gassing at all means that the stripping action is almost or has reached completion, or, if the tank is equipped with an ammeter and volt meter, these meters will give an indication of the stripping progress. As the stripping goes on, the amperage will fall and the voltage will rise until, when complete stripping is effected, the ammeter will practically read zero and the volt meter will read almost full line voltage. This latter method gives an excellent indication of the completion of stripping.

The stripping can be done in a separate tank or along with work that is to be just nickel stripped. However, if the rhodium is to be salvaged, it is worth while to do the stripping in a separate tank, as, in this case, the percentage of rhodium in the sludge will be higher, and it will be more economical to salvage.

Anodic Reactions of Aluminum and Its Alloys in Sulfuric and Oxalic Acid Electrolytes

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and Charles J. Slunder, *Battelle Memorial Inst., Columbus, O.*

This article describes factors, such as temperature, concentration and agitation of electrolyte, time of treatment, current density, and type of alloy treated, which affect the formation of aluminum oxide produced by the anodic treatment of aluminum in sulfuric and oxalic acid electrolytes. Electrolytes used at elevated temperatures or in a more concentrated form tend to produce oxide coatings of lighter weight. The electrolyte must be sufficiently agitated to remove the heat developed at the aluminum anode; otherwise, the oxide coating is dissolved. Long time treatment in the electrolyte brings about a decrease in the efficiency of oxide coating formation. Likewise, a decrease in the current density results in the formation of a lighter weight oxide coating. The purity of the aluminum anode has a marked effect upon the efficiency of oxide coating formation, the highest efficiency being obtained with pure aluminum.

THE anodic oxidation of aluminum is now a well established coating process, and has found extensive use for the decoration and protection of aluminum surfaces.(*4*) The value of anodic coatings for specific applications is usually determined by measurement of one or more of the specific properties required. Properties such as hardness, abrasion resistance, thickness, adsorptive capacity, or resistance to corrosion may be varied widely by changing the coating conditions.

The development of suitable test methods and determination of the effect of the operating variables on the properties of the coatings have been the subject of considerable research. Some of the reports (*2, 3, 4, 7*) on this work have indicated the accuracy of these test methods and their field of application. Although these methods have been found satisfactory, the information they supply on the mechanism of coating formation and the variables involved in the anodic oxidation procedure is limited.

In connection with the development of procedures for measuring coating thickness by stripping methods, R. B. Mason (*5*) discovered that a solution of phosphoric and chromic acids quickly dissolves the oxide coating and has practically no effect on the aluminum. The weight of the coating can thus be readily and accurately obtained. The value of such a method to determine the efficiency of anodic oxidation and to show the effect of either minor or major changes in the coating procedure was immediately apparent. Edwards and Keller (*6*) used the method to determine the apparent current efficiency of the anodic process they showed that, while the aluminum was oxidized and dissolved at approximately 100% efficiency, only about 70% of the aluminum lost was accounted for by the weight of the coating, assuming that it consisted entirely of aluminum oxide. The authors pointed out, however, that this assumption is only an approximation because the coating, when it is formed in sulfuric acid, is known to contain some sulfate and water.

General Procedure

Preliminary experiments indicated that even very small changes in the operating conditions were readily detected by changes in the weight of coating or in the weight of metal removed. A convenient unit for expressing the results was obtained by dividing the weight of coating formed under the conditions of test by the weight of metal removed during the formation of the coating. This "coating ratio"[1] is a measure of the over-all anode efficiency with respect to coating formation. No assumptions regarding the possible composition of the coating are required in the calculation of this "coating ratio." If, with pure aluminum, all the metal which reacts electrochemically were converted to alumina in the coating, the coating ratio would be 1.889. A coating ratio lower than this theoretical figure indicates that alumina has been dissolved by the electrolyte either chemically or electrochemically.

The general procedure followed in these experiments was to weigh the ingredients of the elctrolyte into the glass cell which was either cooled or heated, as required, by running water through a lead coil. The coil also served as the cathode. The acid content of the concentrated sulfuric acid which was used to make up the electrolyte was determined by chemical analysis. The sheet specimens to be anodized were 2 x 3 inches (5.1 x 7.6 cm.), and, in most cases, were thin gage so

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[1] The practical film efficiency of Tarr, Darrin, and Tubbs (*8*), multiplied by 1.899, equals the "coating ratio."

Table I. Effect of Composition of Metal on Anode Efficiency and Coating Ratio

Nominal Alloy Composition[a], %	Anode Efficiency[b], %	Coating Ratio
99.95 Al	100.05	1.399
99.85 Al	99.74	1.370
99.75 Al	99.36	1.367
2S-H (99.2 Al)	97.63	1.352
3S-H (1.2 Mn)	95.17	1.351
52S-H (2.5 Mg, 0.25 Cr)	99.67	1.338
17S-T (4.0 Cu, 0.5 Mn, 0.5 Mg)	80.42	0.918
24S-T (4.5 Cu, 0.6 Mn, 1.5 Mg)	80.83	0.917
75S-T (5.6 Zn, 2.5 Mg, 1.6 Cu, 0.2 Mn, 0.3 Cr)	94.77	1.078
14S-W (4.4 Cu, 0.8 Si, 0.8 Mn, 0.4 Mg)	80.60	0.957

[a] In the last six alloys the balance of the composition is aluminum of commercial purity.

[b] $\%\text{ anode efficiency} = \frac{\text{wt. metal removed}}{\text{theoretical wt. Al}}(100)$.

that the surface area of the edges was neglected in calculating the current density. The temperature of the electrolyte was maintained as close to the desired figure as possible and in no case varied more than ±1° F. (0.5°C.). Stirring is important in order to remove heat and maintain a uniform temperature. Adequate stirring was supplied by a mechanical agitator. The time of anodic oxidation was measured by a stop clock, and the current was obtained by a potentiometer arrangement from a direct current line (motor generator). The recorded quantity of electricity passed through the cell was therefore subject only to errors in the ammeter readings and to the fluctuations in the line current.

In carrying out an experiment, the specimen was cleaned by an etching treatment or anodically coated and stripped in the phosphoric-chromic acid mixture, weighed accurately on an analytical balance anodically treated, rinsed, dried, and reweighed. It was then placed in the stripping solution which contained 35 ml. of 85% phosphoric acid (H_3PO_4) and 20 grams of chromic acid (CrO_3) per liter at a temperature of about 200° F. (93.3°C.) for 5 minutes or until the oxide was all dissolved. The specimen was then rinsed, dried, and weighed again. By subtraction the weight of coating and weight of metal lost were obtained and the "coating ratio" determined as mentioned above. A number of different variables were studied by this procedure.

Surprisingly consistent results were obtained when all the conditions were carefully maintained. Indeed, the weight of metal dissolved from 99.9% aluminum sheet employed as anode in sulfuric acid was so consistent that it appeared to be a more accurate measure of the quantity of electricity than was obtained with the ammeter and stop clock. Since a high purity aluminum anode acts as its own coulometer in the sulfuric acid electrolyte, it is desirable to use the weight of aluminum dissolved as a measure of the current actually employed in the electrochemical reaction. This method eliminates errors from leakage losses in the coated aluminum clips used for suspending the sample in the electrolyte as well as errors because of initial current surges.

Alloy Composition and Surface Pretreatment

The composition of the metal was expected to have an important effect on the coating ratio. A few experiments were made for comparative purposes, but this point is not considered in detail here. In these experiments the aluminum anodes were suspended in the sulfuric acid by means of tantalum clips which show no leakage loss in the sulfuric acid electrolyte at the voltages employed. For the measurement of current, a copper coulometer was connected in series with the aluminum-lead cell. Table I shows the variation in coating ratio caused by alloy composition and indicates the importance of this variable. The specimens were oxidized in 15% sulfuric acid at 12 amperes per square foot (1.3 amperes per sq. dm.) for 30 minutes at 70° F. (21.1° C.).

The metal, which approaches 100% purity, is consumed anodically at close to 100% efficiency. Aluminum of commercial purity (2S) has been checked a number of times and found to dissolve at an anode efficiency of about 97.5%. However, the effect of metal composition is brought out strikingly by the 17S-T and 24S-T specimens. It was known previously that coatings on alloys of this type were not so thick or abrasion resistant as those on pure metal. These figures show that the coating ratio is markedly decreased and also that only about 80% of the current is effective in reacting with the aluminum.

The pretreatment of the surface was also considered as a possible source of variation in the coating weight. Specimens of 2S-H sheet were cleaned by various treatments and oxidized in 15% sulfuric acid for 30 minutes at 70° F. and 12 amperes per square foot. The different surface cleaning treatments did not affect the efficiency of the anodic treatment. The small differences noted were not significant, being approximately in the range of experimental error. There is an indication, however, that severe etching of the surface might cause a slightly lower coating ratio because of a lower current density per unit of actual area.

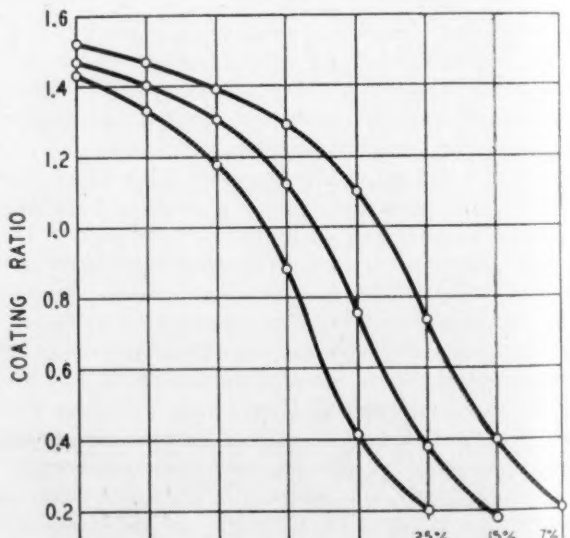

Figure 1. Variation in Coating Ratio with Temperature of Electrolyte for 99.9% Aluminum Anodically Treated for 30 Minutes at 12 Amperes per Square Foot

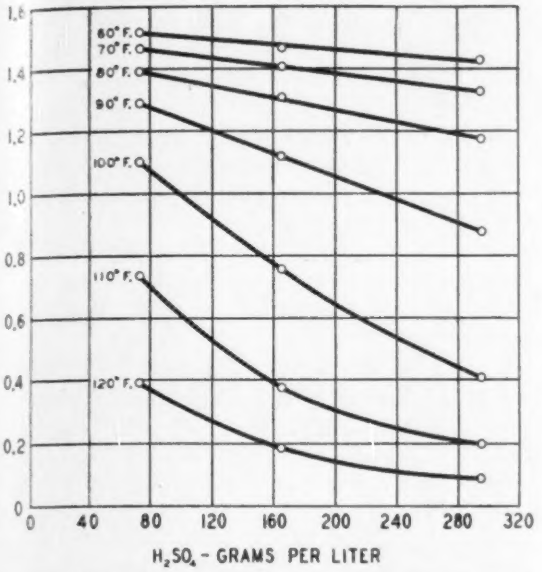

Figure 2. Variation in Coating Ratio with Concentration of Electrolyte for 99.9% Aluminum Anodically Treated for 30 Minutes at 12 Amperes per Square Foot

Concentration and Temperature of Sulfuric Acid

With this background it was possible to consider a number of other factors. The influence of the strength and temperature of sulfuric acid, the current density, and time of anodic oxidation are interrelated. A series of experiments was made in which these variables were investigated separately with careful control of the other factors. In the first group, specimens of 99.9% aluminum were oxidized for 30 minutes at 12 amperes per square foot and temperatures of 60° to 130° F. (15.6° to 54.4° C.) in electrolytes containing 7, 15, and 25% by weight of sulfuric acid. The weight of coating and the coating ratio were determined for each condition. The relaxation existing between these factors is most conveniently shown graphically. Figure 1 presents curves of coating ratio against temperature for the three sulfuric acid electrolytes. These curves have the expected form, since it was known that the hardest and most dense coatings are formed at low temperatures and at low acid concentration. The sharp drop in coating ratio obtained for all three concentrations of acid as the temperature was raised above 90° F. (32.2° C.) indicates that thinner, more porous coatings are formed because of the increased solvent action of the warmer acid.

The same data are plotted in a different manner in Figure 2, to show how the coating ratio decreases with increasing electrolyte concentration. The relation is practically linear up to 100° F. (37.8° C.), and the increasing slope of the lines with rising temperature is evidence of the increased solvent action of the acid under those conditions. The solubility of alumina formed by anodic treatment in influenced by the concentration of the acid and the temperature of the electrolyte.

The curves for electrolyte temepratures of 100°, 110°, and 120° F. (37.8°, 43.3°, and 48.9° C.) graphically show what happens to the coating ratio as the concentration of the acid is raised. Under these conditions the coatings decrease substantially in thickness and abrasion resistance. The fact that the coating ratio is approaching zero at 120° F. in the 25% electrolyte indicates that little or no coating would be produced at about 140-160° F. (60-71.1° C.). The shape of the 120° F. curve seems to indicate that increasing the concentration of the acid beyond 25% would have less effect on the solubility of the oxide coating than raising the temperature 10° or 20° F. (5.6° or 11.1° C.).

For electrolytic brightening, the anodic oxide coating should be removed approximately as fast as it is formed, and this condition is being approached in the 25% sulfuric acid at 120° F. If the current density were decreased, the anodically formed alumina would have a better chance to dissolve and the coating ratio would also decrease (Figure 8).

Current Density

As might be expected, a heavier (and denser) coating is obtained at higher current densities. The reasons for this are: (*a*) the coating is formed at a faster rate; and (*b*) for the passage of the same quantity of electricity, the coating remains in contact with the solution for a shorter time and is subject to less chemical attack. Therefore, the slope of the curve (metal dissolved *vs.* coating ratio) should be steeper at the lower current densities. Figure 3 shows this to be the case.

The metal removed is a measure of the ampere-minutes used in the cell, and the curves show that for the same quantity of electricity, the heavier (and denser) coatings are formed at the higher current densities. This would indicate that, from a practical standpoint, the highest current density consistent with satisfactory properties and economical operation should be chosen. However, the voltage required increases and the coatings have a tendency to be somewhat rough at the higher current densities.

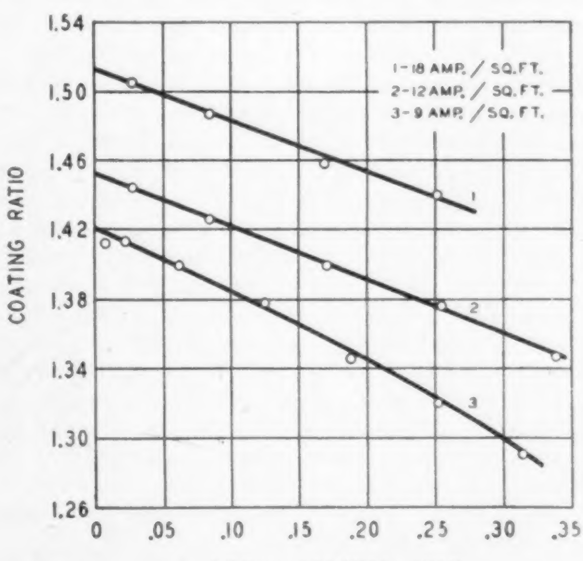

Figure 3. Effect of Current Density on Coating Ratio for 99.9% Aluminum Anodically Treated in 15% Sulfuric Acid at 70° F.

For a 30-minute coating the metal removed is equivalent to 0.168 gram.

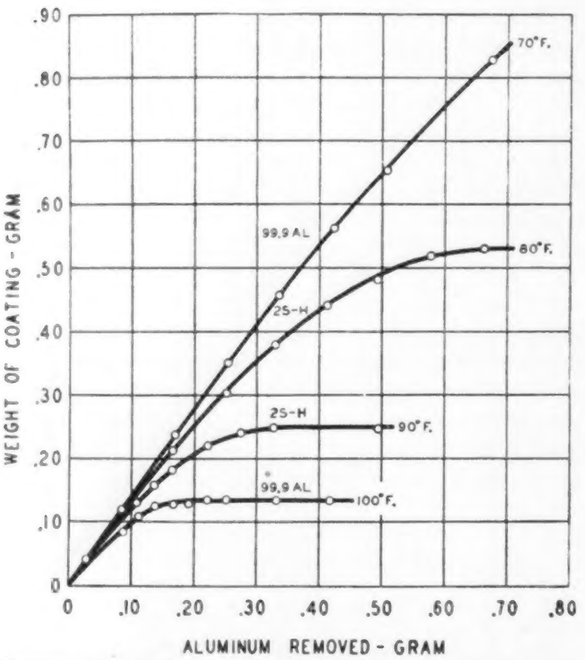

Figure 4. Relation between Aluminum Removed and Weight of Coating Formed at Different Temperatures

Specimens of aluminum 2 × 3 inches, having a surface area of 12 square inches, anodically treated for varying times in 15% sulfuric acid at 12 amperes per square foot.

Time of Anodic Treatment

Figure 3 also shows that higher coating ratios are obtained with thin coatings than with thick ones. This is additional evidence that coatings which remain in contact with the acid electrolyte are gradually dissolved. The greatest coating ratio should therefore be obtained with coatings formed in the shortest time. The coating ratio for each concentration of acid and at each temperature or current density seems to be at its maximum value after about 2-5 minutes of anodic oxidation.

Attempts were made to determine the ratio for the film formed within the first few seconds after the current was applied. The observations were quite variable because of the small quantities involved, but the indications were that the coating ratios were of about the same order as for coatings formed in the 2 to 5 minute coating period. The attempts to prove that the film formed in the first few seconds was composed of alumina equivalent to the aluminum removed were not successful since the maximum ratio obtained was considerably below the theoretical ratio of alumina to aluminum. If this theoretical figure is reached instantaneously or within a few seconds, it is not possible to detect it with this technique. The difference between the theoretical ratio of alumina to aluminum and the observed coating ratio might mean that some of the aluminum which was anodically dissolved did not form oxide but went directly into the electrolyte to form aluminum sulfate (*1*) or some similar compound.

Effect of Temperature and Time on Coating Weight

The fact that alumina can be dissolved by the electrolyte at the same rate as which it is formed can be shown readily by plotting the weight of metal removed, which is proportional to the ampere-minutes, against the weight of the coating formed. Figure 4 shows a family of such curves. The conditions of anodic oxidation were carefully controlled, the only variable being the temperature which was maintained at 70°, 80°, 90°, and 100° F. (21.1°, 26.7°, 32.2°, and 37.8° C.) for the corresponding curves. The shape of the curves indicates the progress of oxidation and emphasizes the importance of the electrolyte temperature in determining the characteristics of the coating. A constant current density was used, and therefore the oxide coating was formed at the same rate at all four temperatures.

The curves clearly show, however, that the oxide coating were dissolved at different rates, depending on the temperature of the electrolyte. The weight of the oxide coating, therefore, depends on the balance that is reached between the rate of formation and the rate of solution. During the anodic process this is continuously changing, up to the point where the solution rate is equal to the oxidation rate. When this point is reached, no further increase in the weight of coating can occur, which is indicated by the flat portion of the curves. The action is then merely anodic solution of aluminum, through the intermediate oxidation stage, and can be continued until all the aluminum is consumed. The solvent action is no doubt controlled by the area exposed to attack and by the temperature of the acid.

The temperature seems to be the more important variable, since each 10° F. rise results in a considerably lower equilibrium value. In the present experiments the curves of Figure 4 indicate that the equilibrium weight of coating is reduced by about one half for every 10° F. rise in temperature.

At a given temperature the total amount of anodically formed alumina going into solution per unit time in the sulfuric acid is determined by the total area exposed. For example, the 100° F. curve in Figure 4 shows that after about 30-minute treatment the rate of solution and the rate of formation are equal. Since the rate of formation remains constant, the coating is increasing in thickness during the first 30 minutes because the area of the pore surface exposed to the electrolyte is not great enough to give the maximum rate of solution of alumina.

When the maximum rate of solution is reached, the pore walls are tapered and the thickness of the pore walls near the surface is at a minimum. The maximum thickness of coating has been reached for the specific operating conditions. The temperature of the

TABLE II. COATING RATIO OBTAINED WITH OXALIC ACID AND OTHER ELECTROLYTES

(99.75% aluminum oxidized for 30 minutes at 12 amperes/square foot and 70° F.)

Electrolyte	Cell Voltage	Metal Removed, Gram	Coating Ratio	Anode Efficiency, %
$(COOH)_2 \cdot 2H_2O$, 30 g./l.	70	0.1558	1.354	92.5
$(COOH)_2 \cdot 2H_2O$, 60 g./l.	62	0.1558	1.366	92.5
$(COOH)_2 \cdot 2H_2O$, 90 g./l.	57	0.1565	1.374	92.8
$(COOH)_2 \cdot 2H_2O$, 90 g./l. + 3% H_2SO_4	25.8	0.1651	1.461	98
$(COOH)_2 \cdot 2H_2O$, 90 g./l. + 6% H_2SO_4	20.8	0.1665	1.454	98.8
H_2SO_4, 15% by wt.	16.5	0.1664	1.381	98.7
$NaHSO_4 \cdot H_2O$, 465.5 g./l.	20	0.1672	1.477	99.2

Table III. Comparison between Sulfuric and Sulfuric-Oxalic Acid Electrolytes at Several Temperatures

(99.9% aluminum oxidized for 30 minutes at 12 amperes/square foot)

Electrolyte Temp., °F.	7% H_2SO_4 Cell voltage	7% H_2SO_4 Coating ratio	9% $(COOH)_2 \cdot 2H_2O$ + 6% H_2SO_4 Cell voltage	9% $(COOH)_2 \cdot 2H_2O$ + 6% H_2SO_4 Coating ratio
70	22	1.467	21.5	1.465
90	17.5	1.291	16.4	1.318
100	15	1.103	13.8	1.199

electrolyte affects the taper of the pore walls. At low temperatures there is only a slight taper; at the higher temperatures the taper is proportionately greater. The size of the pore at the outer surface increases as the temperature is raised and reaches a maximum size when the rate of solution and the rate of formation are equal. Under these conditions the walls of the pores near the outer surface are likely to break down to form a soft chalky layer. This explains the fact that the abrasion resistance of the oxide coating decreases as the temperature of the electrolyte used for formation is raised. Also oxide coatings formed at higher temperatures sorb dyes more readily.

Effect of Aluminum in Sulfuric Acid Electrolytes

The effect of aluminum in the electrolyte has been the subject of some speculation, since it is known that the aluminum content of the acid increases with continued operation of the bath. The weight of coating method seemed to offer promise as a means of detecting any differences in the coatings which might result from aluminum or other additions to the electrolyte.

The presence of aluminum sulfate in amounts up to 20 grams per liter aluminum has no detectable effect on the coating ratio. However, the concentration of the sulfuric acid may have a marked effect on the coating ratio (Figure 2). When aluminum is anodically coated in sulfuric acid, a certain amount of the acid is used up to form aluminum sulfate. While the aluminum sulfate has no effect on the coating ratio, an appreciable decrease in concentration of the acid causes an increase in the coating ratio.

Investigation of Other Electrolytes

A few experiments were made to check the efficiency of oxide coating formation in other electrolytes. Oxalic acid and mixtures of oxalic and sulfuric (*9*) have been used commercially, and it was interesting to determine the weight of coating, or coating ratio, obtainable with these electrolytes. Table II lists the results of these tests.

A number of important points were brought out. For example, the coating ratio obtainable with oxalic acid is only a little lower than with sulfuric acid, but the anode current efficiency, based on weight of aluminum removed, is only 92.5%. This indicates that 7.5% of the current must be consumed in some other electrochemical reaction, possibly oxidation of the oxalic acid.

The addition of sulfuric acid to oxalic raises both anode current efficiency and coating ratio to approximately the figure expected with sulfuric acid alone. The voltage is also lowered considerably. Oxidation with the mixture resembles that with sulfuric acid in operating characteristics. It is known, however, that the oxalic-sulfuric mixtures may be operated at higher temperatures than sulfuric acid alone without the formation of soft coatings. An experiment was therefore conducted to compare the coating ratios of these solutions at several temperatures (Table III).

These results show that, although the coating ratios at 70° F. are practically identical, at 90° F. the coating ratio is appreciably higher when the mixture of sulfuric and oxalic acids is used. The presence of the oxalic acid seems to reduce the attack of the electrolyte on the oxide coating at the higher temperature, the result being a heavier (and denser) coating.

The inhibiting action of certain salts on the solvent action was also noted in the experiments with the sodium acid sulfate electrolyte. Solutions of sodium acid sulfate were made up, and the equivalent free acid was calculated from the reaction:

$$2NaHSO_4 \rightleftharpoons Na_2SO_4 + H_2SO_4 \qquad (1)$$

For example, a solution equivalent in sulfate content to 15% sulfuric acid contained 232.7 grams of hydrated sodium acid sulfate per liter, and this according to Equation 1 was equivalent to 82.6 grams of free sulfuric acid per liter. The coating ratio obtained with the sodium acid sulfate bath was 1.500 (at 70° F. and 12 amperes per square foot for 30 minutes) on 99.9% aluminum, which is somewhat higher than would be expected with an 82.6 gram-per-liter sulfuric acid bath (7-8% sulfuric acid).

Solubility of Coating in Electrolyte

The solvent action of the electrolyte has been mentioned as having an influence on the oxide coating characteristics and in determining the properties of

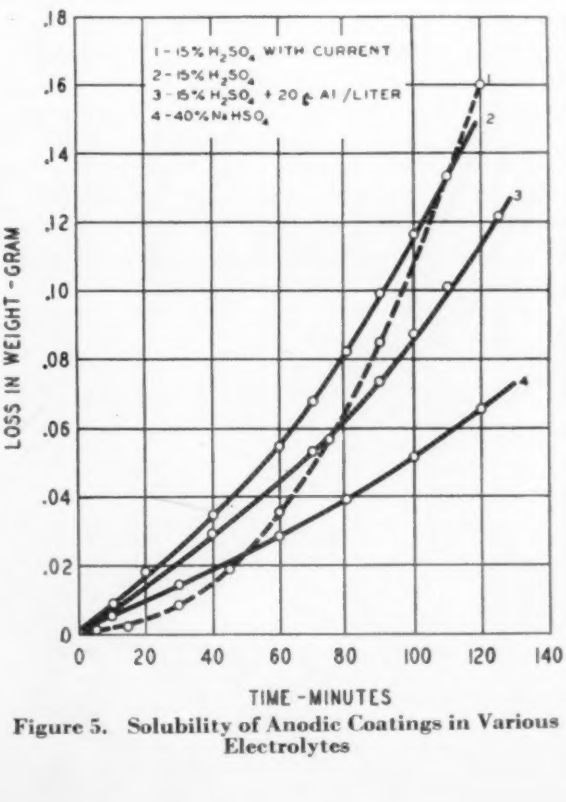

Figure 5. Solubility of Anodic Coatings in Various Electrolytes

TABLE IV. SOLUBILITY OF ALUMINA IN SULFURIC ACID DURING FORMATION OF ANODIC COATING

(99.9% aluminum oxidized in 15% H_2SO_4 at 12 amperes/square foot and 70° F.; area of specimen, 12 sq in.)

Time, Min.	Metal Removed, Gram	Actual Wt. of Coating, Gram	Coating Ratio[a]	Calcd. Theoretical Coating Wt., Gram	Coating Dissolved, Gram
5	0.0285	0.0412	1.442	0.0413	0.0001
15	0.0851	0.1213	1.425	0.1234	0.0021
30	0.1705	0.2386	1.399	0.2472	0.0086
45	0.2552	0.3511	1.376	0.3700	0.0189
60	0.3391	0.4566	1.347	0.4917	0.0351
75	0.4255	0.5602	1.317	0.6170	0.0568
90	0.5086	0.6526	1.283	0.7375	0.0849
120	0.6795	0.8248	1.214	0.9853	0.1605

[a] Coating ratio (no chemical solution) = 1.45 (from Figure 3).

the coating. Since this action is taking place simultaneously with the forming action, the rate of solution is changing continuously up to the equilibrium value for each set of conditions, and its effect is difficult to separate from the oxide coating effect. However, it is possible to measure the solubility of the coatings in the various electrolytes without current flowing and, in this way, determine the relative effect of the acids.

Specimens of 99.9% aluminum with a surface area of 12 square inches were oxide-coated for 30 minutes at 12 amperes per square foot and 70° F. in 15% sulfuric acid. The dried and weighed pieces were then immersed in the electrolytes under consideration at 70° F. with mechanical agitation, and weighed at intervals to determine the weight loss. As Figure 5 shows, a definite difference in solvent action was obtained. The presence of sulfates in the acid partially inhibits the attack of the oxide coating in this static test. The same relation no doubt holds while the coating is in process of formation, and aluminum sulfate in the sulfuric acid electrolyte would perhaps decrease the chemical solvent action on the oxide coating.

The data of Table IV were used to calculate the amount of alumina dissolved during the formation of the anodic coating. If the curve in Figure 3 for a current density of 12 amperes per square foot is extrapolated to cut the y-axis for zero time, a coating ratio of 1.45 is obtained. Any coating ratio obtained under these operating conditions which is lower than 1.45 indicates that some oxide coating has dissolved by standing in the electrolyte. The coating ratio of 1.45 is considerably less than the theoretical value of 1.889. This indicates that some aluminum may pass into the electrolyte without forming oxide.

From the coating ratio values extrapolated to zero time, it is possible to calculate for each time of treatment the weight of oxide coating which would be present if no chemical solution of the coating had occurred. This can be done by determining the amount of metal that has reacted during the oxidation treatment and by multiplying this value by the proper factor (for a current density of 12 amperes per square foot the factor is 1.45). The difference between the computed value and the actual weight of the oxide coating that is obtained is the weight of coating that has dissolved in the electrolyte. Such values are given in the last column of Table IV and are shown graphically in Figure 5 for comparison with other solubility values.

Less coating is dissolved while the coating is being formed by the current than when the coated specimen is merely standing in the electrolyte. The presence of aluminum sulfate in the sulfuric acid has been shown to decrease the solubility of anodically formed alumina. Knowing the method of formation for thick anodic coatings, it is concluded that the high concentration of aluminum sulfate within the pores causes a decrease in the solubility of the coating. It would appear that the electrolyte within the pores contains aluminum sulfate.

Many other experiments of a similar nature were made; all pointed to the usefulness of the weight of coating method for studying the mechanism of oxide coating formation, investigating new electrolytes, and accurately determining the effect of variables in the anodic oxidation procedure.[1] Further knowledge in this field should be gained by an extension of these experiments.

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Electropolishing—A Survey

Compiled by Samuel Wein, *Consultant, New York, N. Y.*

ELECTROPOLISHING, like any other industrial or technical art, is the result of painstaking and slow development; it is not a spontaneous result of one or several investigators. It is, as we shall presently see, the fruits of the combined efforts of a series of investigators. Obviously, of course, the results and products from these various investigators are different, as we might well expect, and, as such, it is well that we consider in its chronological order the development and technique of electropolishing.

In presenting this chronological survey of the technical and patent literature, it should be borne in mind that the present writer assumes no title as "expert" in the subject matter, nor does he assume any authority for accuracy of facts given, since the statements made in this bibliographical survey are the opinions of the individual investigators; for further facts with respect to minute details, the reader is requested to refer to the sources listed, from which the present article is compiled.

The article is divided into two sections, for convenience only; i. e., the segregation of information in its chronological order, followed by information which may be classified as "practical."

Historical Survey

The first published evidence of electropolishing is the work of *Spitalsky*[1] who in 1910 used silver, gold and other metals, so his patent states, as the anode at such current density where the so called passivity phenomenon occurs. The solution referred to is silver cyanide and was made by precipitation from a solution of 25 grams silver nitrate in water with 100 c.c. of a 10 per cent potassium cyanide solution. This precipitate was filtered, washed and then dissolved in 300 c.c. of a 10 per cent potassium cyanide solution, which was then diluted to 1 liter with water. At 5 cm. cathode distance from the anode (silver), electropolishing was accomplished at 2 to 3 volts with 100 to 200 amps. With a milliammeter in the circuit, the current was increased and then gradually decreased. After a time, a stage was reached where the current was decreased still further to operate at a lower current density. In cycles of ½ to 1 minute duration, the current will fluctuate from 20-25 milliamperes to 70-80 milliamperes. The best brightening resulted when the period and amplitude of current changes are smallest. In the only example given, the silver plate was anodically treated at about 0.01 ampere per square centimeter. Two minutes or less time was required to give a highly brightened surface to silver plated spoons. The current changed from 0.06 ampere to 0.12 ampere at 1.2 to 1.3 ohms.

Blau[2] manufactured fine refractory metal wires in 1915 by chemical or electrolytic anode treatment, referring to the use of metallic tungsten. After the wire had been drawn fine enough, through dies, it was further reduced in size (thickness) by means of electrolysis, making it the anode in a suitable bath.

In order to promote adherence of electroplated metals, *Madsen*[3] in 1925 anodically treated steel in a bath containing

Sulphuric acid	86-92%
Water	14- 8%

With a current density of about 100 amperes per square foot at the start, he decreased the current to around 17 amperes per square foot in 1 to 3 minutes. Approximately 42 volts were used. He reported that the surface of the steel as treated by this process had an entirely different appearance to the eye from any other steel treated or untreated and especially from the same steel after pickling, being much whiter and more pearly. This was the first apparent notice of the possibility of electropolishing.

Like Madsen, *Petersen*[4] in 1925 treated steel plate electrolytically to facilitate the adherence of metals prior to electroplating, using a 75% to 100% sulphuric acid solution at 20 amperes per square foot for 6 minutes at 150° F.

Blackburn[5] in 1928 recommended for iron and steel the use of 2 to15 per cent of sulphuric acid at temperatures of 140 to 180° F.

Burns and Warner[6] in the same year recommended electrocleaning methods for the preparation of steel surfaces for electroplating. The method used was anodic electrocleaning where foreign matter attached to the surface was loosened by the evolution of gas and some of the metal taken into solution. The inventors record that longer times will give brighter surfaces. Here again, there is a recognition of the possibilities of electropolishing. The solutions suggested are:

1) Phosphoric acid 100%
   1 Amp. sq. ft.
   100-220° F.
   5 Mins.
2) Phosphoric acid 80%
   Water 20%
   1-12 Amps. sq. ft.
   100-220° F.
   5 Mins.

3) Phosphoric acid 75%
Water 25%
3 Amps. sq. ft.
100-220° F.
5 Mins.

Lahan[7] obtained satin finishes on steel in 1930 by anodic treatment at 100 amperes per sq. ft. in 30 per cent sulphuric acid plus 3 ounces per gallon of potassium dichromate.

Knauss[8] suggested anodic treatment prior to nickel plating. This treatment, developed in 1931, consisted of an 85 per cent concentration of sulphuric acid at 100° F with a current density of about 20 amperes per square foot. This is an improvement on the Madsen and Petersen inventions previously described.

Le Material Telephone[9] used the following solutions:

1) Phosphoric acid 70%
Water 30%
0.4-0.5 Amp. sq. ft. or 3-4.5 Amp sq. ft.
80° F.
5-10 Mins.
Metal: Copper

2) Perchloric acid 75%
Glacial acetic acid 25%
2-4 Amps. sq. ft.
85° F.
5 Mins.
Metal: Nickel

Locke[10] annealed rolled stainless steel in a controlled atmosphere so that the high finish was oxidized only slightly and evenly. The strip then made the anode in an acid pickle bath and then buffed to a high polish. A 10 per cent sulphuric acid bath was discussed.

Fink and Kenney[11] in 1931, described a process of treating metal and alloy articles to improve the resistivity thereof to corrosion and to the product thereof. They state, "The electrolytic treatment is preferably carried out in a bath having an oxidizing action on the metal or alloy being electrolytically treated, whereby at the same time that the surface, or portions thereof, are being dissolved, there is also an oxidizing or passivating of the surface effected." They also state, "While other electrolytic solutions may be used, best results have been obtained by the use of chromic acid solution. Examples of other electrolytic solutions are concentrated sulphuric acid solution, concentrated hydrochloric acid solution, concentrated nitric acid solution."

Fink and Kenny describe their process as a method of equipotentializing the surface of a metal in which differences in potential exist due to presence of particles of different metals, crystal structure, strains, etc. They describe their process as an anodic treatment to dissolve the points or areas of high electrolytic potential. They require that the bath be oxidizing and they recommend a 42.5 per cent chromic acid bath and a temperature of 40 deg. C., current density of 0.06 amp. per sq. cm. and a treatment time of 1 hr. They claim that articles treated by their process are twelve times as resistant to corrosion as those not treated.

To recapitulate, therefore, there is the following to offer with respect to anodic treatment of steel in acid solutions. Hogaboom in 25 to 75 per cent sulphuric acid, Locke in 10 per cent sulphuric acid, Burns in 70 to 100 per cent phosphoric acid, Pedersen in strong sulphuric acid, etc. It would seem quite obvious that what Fink and Kenny claim to have obtained in the way of equipotentializing the surface must have occurred, if it does occur at all, in the cases of Laban, Hogaboom, Locke, Burns, Pedersen and many others who treated metals anodically in acid electrolytes. Certainly Burns' phosphoric acid and Laban's sulphuric acid plus dichromate can be considered as oxidizing acids. Question might be raised as to hydrochloric acid having an oxidizing action, although Fink and Kenny refer to it as one of the acids that might be used.

In 1932 *Hogaboom*[12] descaled steel cathodically in 1 to 6 minutes in a 2 to 20 per cent sulphuric acid solution at a temperature of 70° to 160° F. and with a current density of 10 to 150 amperes per square foot. After descaling cathodically, the work was then bright dipped by being made the anode in a 25 to 75 per cent sulphuric acid bath kept cooled at below 100° F. and with a current density of 80 to 250 amperes per square foot. Hogaboom indicated his belief that the production of the bright surface on the steel was due to anodic formation of persulphuric acid, the maintenance of which was favored by the high current density and the low temperature.

Stainless steel containing chromium or nickel was claimed by *VanMater*[13] in 1934 to convert the scale or oxide film from an insoluble to a soluble form by making the work the anode in an alkaline bath at a temperature of approximately 200° F. Sodium hydroxide solutions containing from 8 per cent to as high as 50 per cent of sodium hydroxide were used. Treatments from a few seconds to two or more minutes were reported. The shorter time periods were used with high current densities and the longer times up to 20 minutes were used with low current densities. Following the anodic treatment in the alkaline solution, the transformed or modified scale or oxide was removed by pickling in 5 to 10 per cent nitric acid solution with or without the addition of a small percentage of hydrofluoric acid.

Jacquet,[14] and subsequently his associates,[15] have used orthophosphoric acid solutions for "anodic polishing of copper for metallographic purposes." His conclusions indicated that this process did not constitute true "polishing," but differentiated from nitric acid pickling, because it effected uniform attack and did not yield a matte surface. They discussed the use of the process for metallographic specimens of brass and other metals.

During the latter part of 1935 and through the year 1936, Jacquet published a series of articles in connection with electropolishing of copper. In these articles, he reported finding a mirror finish on copper by anodic treatment in phosphoric acid. Current densities were adjusted between that of passivity of the copper and of complete corrosion. It was found that copper compounds accumulated in the depressions on the surface of the metal and that passivity prevails in these depressions; the projections remain active and are eaten away until the surface is smooth and mirror-like.

For steel of all kinds, tin and lead, Jacquet developed various mixes and concentrations of acetic anhydride and perchloric acid. Current densities from 4 to as high as 15 amperes per square decimeter were recommended and as high as 100 volts used. There seems to be little question but that these mixtures of acetic anhydride and perchloric acid do develop a polish when used in accordance with the instructions given. It is unfortunate that the instructions given do not refer to the great hazard in the use of perchloric acid. Acetic anhydride itself releases enormous quantities of fumes and is distasteful to work with. The use of these mixes of acetic anhydride and

perchloric acid is permissible for small metallographic specimens being treated in the laboratory providing the operator is fully acquainted with the nature of the chemicals being used, and providing proper care is taken to prevent explosions. Any plant adaptation of such reagents in large amounts for quantity treatment of metals should be avoided if possible.

The literature accredits Jacquet and his co-workers with the following formulations:

A—PERCHLORIC-ACETIC (NO WATER)

1) Perchloric acid 33.5%
Glacial acetic acid 66.5%
0.4 Amp. sq. ft.
85° F.
30 Sec.
Metal: Electrical sheet with 3% silicon.

2) Perchloric acid 30%-34%
Glacial acetic acid 70%-66%
.8 to 1.6 Amps. sq. ft.
68°-85° F.
5 Mins.
Metal: Lead.

3) Perchloric acid 20%
Acetic anhydride 80%
0.2 to 0.4 Amps. sq. ft.
100° F.
15 Mins.
Metal: Aluminum.

B—PERCHLORIC-ACETIC-WATER

4) Perchloric acid ... 18.5%-35 %
Acetic anhydride .. 63 %-76.5%
Water .... 2 %- 9 %
0.3-5 Amps. sq. ft.
68°-85° F.
5-10 Mins.
Metals: Aluminum, lead, carbon steel.

C—PHOSPHORIC-WATER

5) Phosphoric acid 63%-70%
Water 37%-30%
0.02-0.5 Amp. sq. ft.
80° F.
5 Mins.
Metals: Brass, copper.

6) Pyrophosphoric acid 58%
Water 42%
0.5-0.7 Amp. sq. ft.
68° F.
10-15 Mins.
Metal: Copper.

D—MISCELLANEOUS SOLUTIONS

7) Sulphuric acid 17%
Calcium phosphate (phosphoric acid added)
Sodium sulphate added to saturation
1 Amp. sq. ft.
75° F.
1.5 Min. as anode
1.5 Min as cathode.
Metal: Copper.

8) Trisodium phosphate . 160 grams
Water .... 1 liter
0.6 Amp. sq. ft.
100°-120° F.
10 Mins.
Metal: Tungsten.

9) Caustic soda 10%
(aqueous solution)
0.2-0.4 Amp. sq. ft.
68° F.
8-10 Mins.
Metal: Lead.

Mason and *Tosterud*[16] formed bright aluminum surfaces in early 1936 by treating the surface anodically in a solution containing from 1 to 60 per cent of sulphuric acid plus 0.2 to 1.5 per cent of hydrofluoric acid. Voltages of 8 to 10 volts and current densities up to 100 amps. per sq. ft. and temperatures up to 60 deg. C. were reported. It was claimed that the original buffed specular reflecting surface had its reflection factor increased as the result of this treatment.

Sutton's[17] recommendation for electropolishing of steel are in effect the same as those of Lahan, and called for anodic treatment in a 30 per cent sulphuric acid solution containing 3 ounces per gallon of potassium dichromate and a current of 100 amperes per square foot. This treatment was reported to leave the steel surfaces passive and with a clean satin surface or finish.

Muller and *Harant*[18] used ferrous sulfate solutions containing 0.1 per cent sulphuric acid for electropolishing steel. This was developed in 1936.

Oberflachen[19] summarized the European situation in 1937 by a discussion closing with "by all means an electrolyte must be found in which one can also polish other metals, especially iron, and in which alloys with several structural constituents can be polished."

In June of 1937 a German patent[20] was granted using the following solution:

1) Sulpruhic acid 70%
Water 30%
2-4 Amps. sq. ft.
100° F.
5 Mins.
Metal: Nickel.

Meyer and *Dunleavey*[21] patented the following in 1937:

1) Water .... 200 c.c.
Sulphuric acid .... 80 c.c.
Nitric acid .... 20 c.c.
Hydrochloric acid .. 1 c.c.
Chromic acid ..... 55-60 gms.
Metal: Stainless steel.

Vernon and *Stroud*[22] in 1938 used:

1) Potassium hydroxide 25%
(aqueous solution)
16 Amps. sq. ft.
2-6 Volts.
Room temp.
15 Mins.
Metals: Zinc and tin.

Elmore[23] described:

1) Orthophosphoric acid
(sp. gr. 1.35)
1.2 Volts.
Metal: Cobalt.

Considerable details are given by *Blaut* and *Lang*[24] in 1938 for descaling of all stainless steel. A bath of about 50 per cent sulphuric and 10 per cent hydrofluoric acid is used. For electropolishing or the burnishing process, a bath of 40 per cent sulphuric and 10 per cent hydrofluoric acid is used. Operation is at room temperature or lower and current densities are of the order of 0.5 to 2 amp. per sq. in.

While this original Blaut-Lang Process is of considerable value and has its applications, there are operating objections to the use of acid pickling baths containing 10 per cent hydrofluoric acid. The fumes are bothersome, although not as dangerous as acetic anhydride plus perchloric acid, and problems develop in connection with suitable tanks or vats for operation. Blaut and Lang continued to work intensely to develop other electropolishing baths which would get around their difficulties. This they have accomplished and the present Blaut-Lang baths for successful operation on all types of stainless steel, nickel, monel, aluminum and aluminum alloys contains no hydrofluoric acid. These baths are the subject of further patent applications now in the Patent Office.

The new Blaut-Lang bath for use on all forms of stainless steel for electro-

polishing has a base of phosphoric and sulphuric acids. It produces an electropolish on all grades of stainless steel.

1) Sulphuric acid 55%
Hydrofluoric acid 7%
Water 38%
0.5-2 Amps. sq. ft.
70° F.
0.5-4 Mins.

2) Sulphuric acid 69%
Hydrofluoric acid 10%
Hydrogen peroxide 21%
2 Amps. sq. ft.
70° F.
5 Mins.

3) Sulphuric acid 73%
Hydrofluoric acid 13%
Water 14%
3.5 Amps. sq. ft.
70° F.
5 Mins.

Priston, Hothersall and *Hammond*[25] in England worked with:

1) Sulphuric acid 73%
Water 27%
1-3 Amps. sq. ft.
80° F.
2 Mins.
Metal: Nickel.

Hughes and *Coomes*[26] discuss the use of a

1) Caustic soda 10%
(aqueous solution)
0.2-0.4 Amp. sq. ft.
68° F.
20-30 Mins.
Metal: Tungsten.

Lindh[27] in January, 1939, reported the development of a bath for bright nickel surfaces in the use of sulphuric acid bath of 45 deg. to 62 deg. Bé at a temperature of 140 deg. F. and with current densities of 280 to 560 amps. per sq. ft. as a method of brightening nickel plated surfaces. It is interesting to note that Proctor recommended a sulphuric acid bath of this concentration for stripping nickel. Proctor, however, used current densities of only 5 to 10 amps. per sq. ft. instead of the high current densities of Lindh.

Stainless steel to develop a more corrosion resistant surface, according to *Uhlig*,[28] is treated with a mixture of sulphuric and hydrochloric acids to which some titanium tetrachloride has been added.

No description is given of the technique to be followed in adding the titanium tetrachloride to the solution or holding it in the solution once it has been added.

1) Sulphuric acid .... 40 %
Hydrochloric acid 29.5%
Titanium tetrachloride .. 5.5%
Nitric acid 0.5%
Water 24.6%
Specimen as cathode.
170° F.
2-5 Mins.

2) Sulphuric acid 40%
Hydrochloric acid 30%
Titanium tetrachloride ... 5%

Burkhardt[29] added organic compounds to the stainless steel polishing solutions, as in the case of:

1) Phosphoric acid 40%
Glycerol, tallow, benzoic acid, picric acid or inhibitors 50%
Water 10%
0.5 Amp. sq. ft.
212° F.
10 Mins.

2) Sulphuric acid 48%
Glycerol 32%
Water 20%
3.5 Amps. sq. ft.
120°-160° F.
40 Mins.

Kiefer,[30] working with stainless steel described:

1) Phosphoric acid 70%
Water 30%
432 Amps. sq. ft.
100°-220° F.
5 Mins.

An anonymous writer[31] in 1939 recalled that wire anodes became very brilliant in certain electrolytic solutions, and developed a method of anodic polishing of nickel, aluminum, iron, copper, tungsten and molybdenum in sulphuric acid and in acetic-perchloric acid mixture.

Hagony[32] used:

1) Perchloric acid 20%
Ethyl alcohol 80%
13-40 Amps. sq. ft.
95° F.
10-15 Sec.
Metal: Stainless steel.

2) Phosphoric acid 75%
Water 25%
3 Amps. sq. ft.
100°-220° F.
5 Mins.
Metal: Stainless steel.

Hothersall and *Hammond*[33] described, in 1940, the following:

1) Sulphuric acid 73%
Glycerol or toluene sulphonates 20%
Water 7%
1.5 Amps. sq. ft.
85° F.
0.5-5 Mins.
Metal: Stainless steel.

2) Sulphuric acid 58%
Glycerol 20%
Water 22%
1-2 Amps. sq. ft.
70°-100° F.
5 Mins.
Metal: Stainless steel.

3) Sulphuric acid 73%
Water 27%
1-3 Amps. sq. ft.
80° F.
2 Mins.
Metal: Nickel.

Feild and *Clingan*,[34] in 1940, described:

1) Sulphuric acid 20%
Citric acid 55%
Water 25%
0.5-1.5 Amps. sq. ft.
180°-190° F.
5 Mins.
Metal: Stainless steel.

Gordon and *Cohen*[35] discussed the use of a dilute aqueous solution of fluoboric acid to electropolish aluminum in 1940.

Pellisier and *Mahl*[36] are accredited with the use of:

1) Perchloric acid 34%
Acetic anhydride 66%
0.5 Amp. sq. ft.
85° F.
5 Mins.
Metal: Stainless steel.

2) Nitric acid 34%
Methyl alcohol 66%
10 Amps. sq. ft.
90°-100° F.
1 Min.
Metal: Stainless steel.

Mantell[37] used strong acid solutions such as:

Perchloric acid 34%
Acetic anhydride 66%
0.5 Amp. sq. ft.
85° F.
5 Mins.
Metal: Stainless steel.

Roehl,[38] in 1940, electropolished high and low carbon steels, and nickel with:

1) Caustic soda .... 8 gms.
Water .... 1 liter
Soda bicarbonate .... 1.06 gms.
100 Amps. sq. ft.
140° F.
2 Mins.

2) Sulphuric acid 25%
(aqueous solution)
20 Amps. sq. ft.
10 Mins.

deSy and *Haemers*,[39] in 1941, are accredited with the use of:

1) Perchloric acid 20%
Ethyl alcohol 80%
13-40 Amps. sq. ft.
95° F.
10-15 Sec.
Metals: Aluminum and stainless steel.

2) Perchloric acid 20%
Ethyl alcohol with 3% ether 80%
13-16 Amps. sq. ft.
95° F.
8-12 Sec.
Metal: Aluminum.

3) Same as formula No, 2.
13-32 Amps. sq. ft.
68° F.
10-15 Sec.
Metal: Steel (carbon and alloy).

Englehardt[40] in Germany describes:

Pyrophosphoric acid 58%
Water 42%
0.5-0.7 Amps. sq. ft.
68° F.
10-15 Sec.
Metal: Copper.

Farlow and *McCreery*[41] used:

1) Perchloric acid 19%
Acetic anhydride 76%
Water 5%
0.6-4 Amps. sq. ft.
85° F.
4-10 Mins.
Metal: Stainless Steel.

2) Perchloric acid 18%
Acetic anhydride 76%
Water 6%
2 Amps. sq. ft.
85° F.
30 Sec.
Metal: Hadfield's Manganese Steel.

The stainless steel electropolishing solutions accredited to the efforts of *Dr. Faust*[42] and his fellow workers[43] are:

1) Phosphoric acid 100%
1 Amp. sq. ft.
100-220° F.
5 Mins.

A—PHOSPHORIC-SULFURIC TYPES

1) Phosphoric acid 30-65%
Sulphuric acid 15-60%
Water 10-22%
.2-3.5 Amps. sq. ft.
85-300° F.
5 Mins.-I Hour.

B—PHOSPHORIC-SULFURIC-CHROMIC TYPES

2) Phosphoric acid 15-67%
Sulphuric acid 15-60%
Chromic acid 2-10%
Water 9-15%
1.7-4 Amps. sq. ft.
120° F.
½-1 Hour

C—MISC. HIGH-PHOSPHORIC TYPES

1) Phosphoric acid 70%
Chromic acid 10%
Water 20%
0.7-3.5 Amps. sq. ft.
100° F.
5 Mins.

2) Sulphuric acid 15%
Phosphoric acid 63%
Perchloric acid 5%
Water 17%
50-250 Amps. sq. ft.
100° C.
1 Hour

3) Phosphoric acid 60%
Arsenic acid 15%
Water 20%
1.8 Amps. sq. ft.
120-160° F.
40 Mins.

D—HIGH ARSENIC-ACID TYPES

1) Sulphuric acid 35%
Arsenic acid 47%
Water 17%
0.3-0.7 Amp. sq. ft.
140° F.
60 Mins.

2) Sulphuric acid 25%
Arsenic acid 69%
Water 6%
0.3-0.7 Amp. sq. ft.
140° F.
2-90 Mins.

3) Sulphuric acid 10%
Arsenic acid 77%
Water 13%
0.3-0.7 Amp. sq. ft.
140° F.
20-90 Mins.

4) Arsenic acid 84%
Chromic acid 10%
Water 6%
2.5 Amp. sq. ft.
140° F.
10 Mins.

E—GLYCEROL-ACID TYPES

1) Sulphuric acid 50%
Glycerol 40%
Hydrochloric acid 2%
Water 8%
50 Amps. sq. ft.
45° F.
2 Hours.

2) Sulphuric acid 50%
Glycerol 40%
Water 10%
7 Amps. sq. ft.
180° F.
8 Mins.

3) Phosphoric acid 13%
Sulfuric acid 16%
Glycerol 56%
Water 15%
7 Amps. sq. ft.
120° F.
5 Mins.

F—MISC. TYPES

1) Sulphuric acid 60%
Ammoniated glycerhizin 0.01%
Methanol 0.55%
Water 40%
14 Amps. sq. ft.
165° F.
2 Mins.

2) Arsenic acid 10%
Chromic acid 77%
Water 13%
0.7 Amp. sq. ft.
140° F.
60 Mins.

3) Sulphuric acid 75-100%
(aqueous solution)
20 Amps. sq. ft.
150° F.
5 Mins.

Delaplace and *Bechard*[44] patented the following:

1) Pyrophosphoric acid . 400 gms.
Alcohol to make .... 1 liter
2 Amps. sq. ft.
100-220° ft.
10 Mins.
Metal: Stainless Steel.

Imboden and *Sibley*[45] in 1942 used the following:

1) Perchloric acid 18.5%
Acetic anhydride 70.5%

Water ... 5.0%
0.3-0.8 Amp. sq. ft.
68° F.
4-5 Mins.
Metals: Steel, carbon and alloy.

2) Phosphoric acid ... 48%
Sulphuric acid ... 40%
Water ... 12%
5-8 Amps. sq. ft.
95-120° F.
10 Mins.
Metals: Steel

3) Phosphoric acid ... 45%
Sulphuric acid ... 39%
Glycerol ... 7%
Water ... 9%
3-7 Amps. sq. ft.
100° F.
5-10 Mins.
Metal: Steel.

4) Phosphoric acid ... 46%
Sulphuric acid ... 40%
Dextrose ... 4%
Water ... 10%
1.5-4.5 Amps. sq. ft.
80-100° F.
5-10 Mins.
Metal: Steel.

5) Phosphoric acid ... 65%
Sulphuric acid ... 15%
Chromic acid ... 5%
Water ... 15%
3-7 Amps. sq. ft.
100-130° F.
3-5 Mins.
Metal: Steel.

Young and *Brytczuk*[46] used:

1) Acetic anhydride ... 76.5%
Perchloric acid ... 18.5%
Water ... 5%
Alcohol ... 0.5%
0.45 Amp. sq. ft.
22-34 Volts
26° C.
Metal: Steel.

Foss and *Shiller*[47] are accredited with a solution:

Phosphoric acid ... 63%
Water ... 37%
0.02-0.05 Amp. sq. ft.
68° F.
5 Mins.
Metal: Copper.

Parcel's[48] modification is made up of:

1) Perchloric acid ... 66%
Ethyl alcohol ... 80%
Water ... 14%
30 Amps. sq. ft.
85° F.
30 Sec.
Metal: Stainless Steel.

Gilbertson and *Fortner*[49] describes the following solution for silver:

1) Silver cyanide ... 38 ozs.
Free potassium cyanide ... 50-100 ozs.
potassium dichromate ... 38 gms.
Water ... 1 liter
3-8 Amps. sq. ft.
25° C.
1-9 Mins.

Wernick[50] added glycerol to the phosphoric acid solution in 1942-3, as in the case of:

1) Phosphoric acid ... 42%
Glycerol ... 47%
Water ... 11%
0.1-0.6 Amps. sq. ft.
200-300° F.
8-15 Mins.
Metals: Stainless Steel, Nickel, Aluminum.

Manuel[51], in 1943, described zinc cleaning and polishing solutions made up of:

1) Chromic acid ... 7%
Sodium dichromate ... 22%
Sulphuric acid ... 6%
Acetic acid ... 7%
Water ... 58%
2 Amps. sq. ft.
Metal: Zinc.

Ostrovsky[52] added citric acid to sulphuric acid as in the case of:

1) Sulphuric acid ... 15%
Citric acid ... 60%
Water ... 25%
0.5-40 Amp. sq. ft.
125-250° F.
0.5-3 Mins.
Add 4% of total volume of methyl or other alcohols such as ethyl, propyl, butyl, glycerol, glycol.
Metal: Stainless steel.

Rodda[53] used dilute chromic acid solutions as in the case of:

1) Chromic acid ... 16%
Water ... 84%
60-80 Amps. sq. ft.
Metal: Brass.

2) Chromic acid ... 17%
Water ... 83%
16 Amps. sq. ft.
Metal: Zinc.

Possochin[54] also in 1943, described the use of acetic anhydride and perchloric acid solutions as in the case of:

1) Perchloric acid ... 32%
Acetic anhydride ... 64%
Water ... 4%
0.4 Amp. sq. ft.
85° F.
5 Mins.
Metal: Stainless Steel.

Beckwith's[55] solution for stainless steel in 1944 was made up of:

1) Phosphoric acid ... 50%
Sulphuric acid ... 40%
Glycine, 7 lbs. dissolved in hot water ... 10%
3-4 Amps. sq. ft.
160° F.
2-3 Mins.

Clingan[56] used strong solutions of perchloric acid as in the case of:

1) Perchloric acid ... 75%
Water ... 25%
2-4 Amps. sq. ft.
50-85° F.
5 Mins.
Metals: Iron & Stainless steel.

Clingan[57] also used:

1) Sulphuric acid ... 60%
Aqueous solution
6 Amps. sq. in.
30-50° C.
Metal: Chromium-nickel stainless steel and iron.

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Shop Problems

Abrasive Methods—Surface Treatments—Control
Electroplating—Cleaning—Pickling—Testing

METAL FINISHING publishes, each month, a portion of the inquiries answered as a service to subscribers. If any reader disagrees with the answers or knows of better or more information on the problem discussed, the information will be gratefully received and the sender's name will be kept confidential, if desired.

Rust Spots Through Silver Plate

Question: We are experiencing trouble lately with rust spots coming through our silver plating on carbon steel knives. Our operations are as follows:

1—Electrolytic clean in alkaline cleaner.
2—Pickle in 50% sulfuric acid.
3—Pumice scratch brush.
4—Silver strike.
5—Plate in regular 4 oz./gal. silver solution.
6—Rinse in hot then cold water and dry.

Can you advise us as to what can be causing this spotting out?

A. L. S.

Answer: To overcome this problem I would recommend a coating of copper under the silver. This copper can be plated from the usual cyanide solution just prior to the silver strike. Would also advise thorough rinsing after acid pickle so as not to trap any acid in the pores of the metal.

Nickel Plating By Immersion

Question: Can you give me a solution formula from which I can produce a Nickel plating by immersion only, without the use of an electric current?

A. L.

Answer: There has recently been announced by the Bureau of Standards of a new solution for immersion nickel plating as follows:

Nickel chloride	30 gm/L
Sodium Hypophosphite	10 gm/L
Sodium Citrate	100 gm/L
Ammonium Chloride	50 gm/L
pH	8-10

The deposits are said to be adherent and bright. The plating rate is about .0002-.0008 in. per hour. Control of pH is important to the successful operation of the bath, and the temperature must be maintained above 90 C. Because the throwing power of the solution does not depend on the current distribution, objects having deep recesses, which in the usual methods of electroplating would have to have internal anodes, can be evenly coated. The composition of the bath is not critical, but due to the high cost of the chemicals involved, notably the Sodium Hypophosphite, the method is considerably more expensive than the electroplating method.

Chemicals for Lilac Gold Solutions

Question: I am very much interested in making up a lilac gold solution as per the formula in your guidebook, but have been unable to obtain the Potassium Zinc Cyanide that the formula calls for. Can you tell me where I can obtain this material?

M. G. F.

Answer: You can make your own Potassium Zinc Cyanide by combining Potassium Cyanide and Zinc Cyanide in solution. The ratio of these two materials in the double salt is 47.5% of Zinc Cyanide to 52.5% of Potassium Cyanide. Therefore if the formula is given in weight of the double salt, you would only have to multiply this figure by .475 to get the weight of Zinc Cyanide needed, and by .525 to get the weight of potassium Cyanide needed.

Medium Red Gold Deposits

Question: I am interested in plating gold on jewelry, but I would like to produce a color that is somewhere between a yellow gold and rose gold. Can you tell me how this can be done?

A. A. W.

Answer: The essential difference between red and yellow gold formulas is that small amounts of copper cyanide and sometimes posassium ferrocyanide are added to the usual yellow gold formulas to produce a redder deposit. In order to produce a color in between, I would suggest that you start with a solution as follows, then add small amounts of copper cyanide and potassium ferrocyanide until you get the color deposit that you want. The additions of copper cyanide and ferrocyanide should be made in amounts not exceeding 1/4 oz./gal. at a time.

Sodium Gold Cyanide	.5-.75 oz./gal.
Sodium Cyanide	1.5-2.0 oz./gal.

Once you have obtained the color you want, the bath should be analyzed and the exact conditions of temperature and voltage adhered to, as these also have some effect on the color of the deposit.

Peeling Nickel Plating

Question: I am having trouble with my nickel plating. It is chipping off the parts. I have a 68 gallon tank made up as follows:

Copper Cyanide	3 oz./gal.
Sodium Cyanide	4.5 oz./gal.
Sodium Carbonate	2 oz./gal.

Can you help me on this?

A. L. M.

Answer: You state that your trouble is with nickel plating, and you have only furnished the analysis of your copper tank. In order to help you out there is a great deal more information required for an accurate diagnosis of your problem. The base metal, cleaning cycle used, and type of nickel bath used, together with the operating conditions such as current density and temperature, all must be considered. If you would care to furnish this additional information a solution to your problem can no doubt be suggested.

Chrome Plating Deep Articles

Question: In chrome plating covers for coffee urns we have run into the problem of the inside surface not taking the plate. The other surfaces seem to plate all right. We have tried different cleaning cycles but this does not seem to help. A sketch of the part is enclosed. Can you suggest anything that will help us to overcome this problem?

R. K. P.

Answer: The sketch of the part in question indicates that the cover is over 5 inches deep. The throwing power of chrome solutions is notably low, and I believe the answer to your problem is an auxiliary anode hung inside the cover to permit plating into this deeply recessed area. The fact that the other areas plate satisfactorily would indicate that the bath composition is all right.

Buying Uranium Salts

Question: I would like to obtain some Uranium Nitrate for plating experiments, and was told that I would have to obtain a license for this material. Can you give me any information on this?

D. H.

Answer: The sale of Uranium and other salts of radioactive metals is subject to strict control, but small amounts for legitimate experimental and laboratory work are obtainable. A license to buy these materials must first be obtained from the Atomic Energy Commission. Your laboratory supply dealer can give you the full details and the necessary forms. A maximum limit is set on the amount which can be purchased.

Standard Solutions

Question: I would like to purchase standard solutions of Sodium Thiosulfate for analyzing plating solutions so that I can avoid having to standardize them myself. Where can I obtain these?

W. J. B.

Answer: The names of several chemical supply houses that can furnish these standardized solutions are being sent to you. Sodium Thiosulfate does not keep well, and I would suggest that you take about a quart sample of your plating solution and put it in a clean well-stoppered bottle to be used as a standard sample. When you receive your thiosulfate solution, check this standard sample with the standard thiosulfate solution and mark this analysis on the plating solution bottle. At any later time you can check the factor of the thiosulfate solution by running through a sample of this standard plating solution and calculating the new factor for the thiosulfate. This will insure accurate results regardless of any decomposition of the thiosulfate solution with age.

Imitation Gold Plating

Question: Can you put us in touch with manufacturers of imitation yellow and red gold plating solutions in which there is no gold?

E. S.

Answer: Electroplating baths giving yellow and red colored deposits containing no gold are commonly used, and are called brass or bronze solutions. The deposit is made up of copper and zinc in various proportions. Yellow deposits are high in zinc and reddish deposits are higher in copper content, and colors in between may be obtained by varying bath composition and plating conditions, particularly temperature. The make-up of these solutions is given in the Guidebook and Directory, together with the necessary data on plating conditions. It should be borne in mind that the deposits obtained from these baths will not have the same properties as would a regular gold plate.

Black Contact Points in Silver Plating

Question: In silver plating brass parts, we continually note a blackening and staining at the point of contact of the piece with the rack. The voltage used is 1 volt. Can you tell us what possible causes there might be for this condition and how we can overcome them?

W. R.

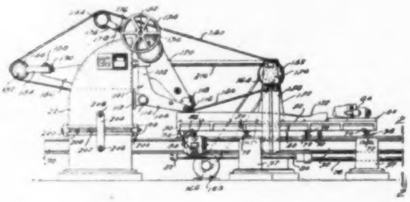
Answer: I believe that your trouble is either poor contact of the work with the rack, or else the contact is being made in such a way that previous solutions are trapped and do not allow plating to take place in this area. Also there may be some shielding effect due to the nature of the contact. The fact that the other areas of the pieces plate satisfactorily seems to indicate that the bath is operating properly. Try other means of contact and thorough rinsing before plating.

Patents

Abrasive Belt Polishing Machine

U. S. Patent 2,431,822. *Ernest E. Murray.*

Apparatus for finishing and contouring a propeller blade, comprising a standard, an elongated article support mounted on said standard for reciprocable movement thereon, an



endless abrading element mounted above and adjacent said article support, a roller element having a length greater than the width of the article being formed, means pivotally mounting said roller transversely of said article support above the lower reach of said abrading element for free vertical movement so that said roller element is disposed to engage and urge said abrading element into engagement with the article, means mounting said article support for tilting movement with respect to said roller element in a plane substantially normal to the direction of said reciprocable movement, elongated cam means mounted on said article support for movement therewith and having a cam surface facing said roller element, follower means mounted on said mounting means for the roller element and movable therewith, said follower means engaging said elongated cam means to cause said support to tilt to various angles as it reciprocates with respect to said roller element, means for adjusting said roller with respect to the article support independently of the position of the follower means, means for reciprocating said support, and means for driving said abrading element.

Coloring Stainless Steel

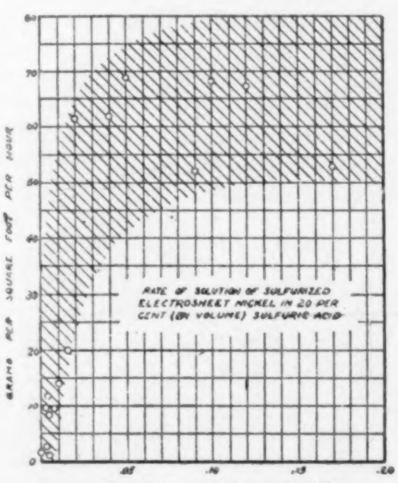
U. S. Patent 2,431,986. *Irvine Clayton Clingan, assignor to The American Rolling Mill Co.*

In coloring stainless steel including about 10% to 35% chromium, the art of producing a colorful coating thereon ranging from straw to blue-black, which includes immersing the stainless steel for a period of about 5 minutes to about 40 minutes in a molten salt bath essentially consisting of one or more of sodium nitrate and potassium nitrate maintained at a temperature in the range of about 730° F. to about 840° F. depending upon the color desired.

Manufacture of Nickel and Cobalt Salts

U. S. Pat. 2,431,997. *Arthur H. Du Rose, assignor to The Harshaw Chemical Co.*

In the manufacture of compounds of nickel and cobalt from the metal, the steps of sulfurizing a body of metal of the class consisting of nickel and cobalt and alloys of nickel and cobalt by heating such body in contact with a sulfurizing agent of the class consisting of hydrogen sulfide, sulfur, carbon bisulfide, sulfur chloride, sulfur dioxide with a reducing gas, and the sulfides of copper, lead, iron, nic-



kel, cobalt and manganese and mixtures of such materials, the temperature of heating being at least 300° C. and being continued for a sufficient time to introduce from .01% to 2% of sulfur, calculated as elemental sulfur, into the metallic body and to diffuse the same there-through, and then dissolving the resulting sulfurized metallic body in an acid of the class consisting of sulfuric, hydrochloric, nitric, acetic and formic.

Treatment of Ferrous Metals to Improve Resistance to Rusting

U. S. Patent 2,431,728. *Gerson Kurt Gergstein, assignor to Despo Mfg. Co., Ltd.*

Process for treating ferrous articles capable of rusting to inhibit the formation of rust thereon which comprises preheating said articles, then subjecting them at a temperature between 100° C. and 200° C. to an aqueous alkaline bath containing from 28.5% to 42.5% solid caustic soda, 3.25% to 15% of alkali silicate, 2.33% to 9.5% of an oxidizing agent selected from the group which consists of alkali metal nitrate, alkali metal nitrite, alkali metal chlorate, alkali metal permanganate, alkali metal bichromate, alkali metal peroxide and nitrophenol, the balance being an amount of water rather less than the weight of solids.

Metallizing Nonmetallic Bodies

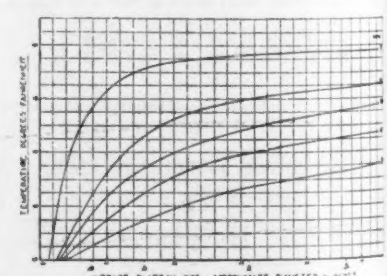
U. S. Patent 2,430,581. *Leopold Pessel, assignor to Radio Corp. of America.*

The process of metallizing a nonmetallic body which comprises depositing on said body a metallic film by bringing it in contact with a solution containing the salt of a metal selected from the group comprising nickel and cobalt, a reducing agent comprising a mixture of a hydrazine compound and a hypophosphite, removing the metallized body from the solution, and heating said metallized body to a temperature above 100° C. but below the flow point of said body.

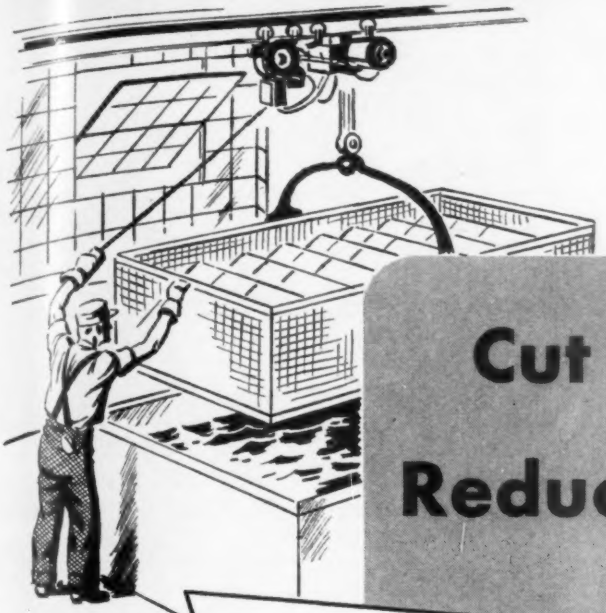
Method of Electroplating to Produce Fissure Network Chromium Plating

U. S. Patent 2,430,750. *Theodore H. Webersinn and Jacob Hyner, assignors to United Chromium, Inc.*

A method of producing articles having chromium electrodeposits thereon with a fissure network therein and firm areas within said fissure net-work having an average diameter of two hun-



dredths of an inch for sustaining the frictional load of moving parts bearing on said plateaus, comprising electrodepositing the chromium from a chromic acid bath to a minimum thickness of one thousandth of an inch at the usual commercial current densities for the bath temperature at which the

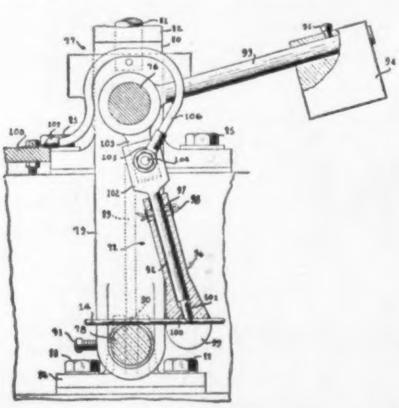


plating is done, within the range 1 to 12 amperes per square inch, under correlated conditions of temperature and ratio of CrO_3 to SO_4 related to said average plateau diameter, etching the chromium electrodeposited as herein stated to develop a fissure net-work with plateaus therein of said average diameter of two hundredths of an inch to which it is predisposed, and mechanically finishing the firm plateaus to produce a smooth bearing surface.

Continuous Wire and Strip Electroprocessing Machine

U. S. Patent 2,431,065. *Constantine G. Miller, assignor to The Meeker Co.*

In an electrogalvanizing machine for continuously electrogalvanizing multiple metal strands, means for mov-

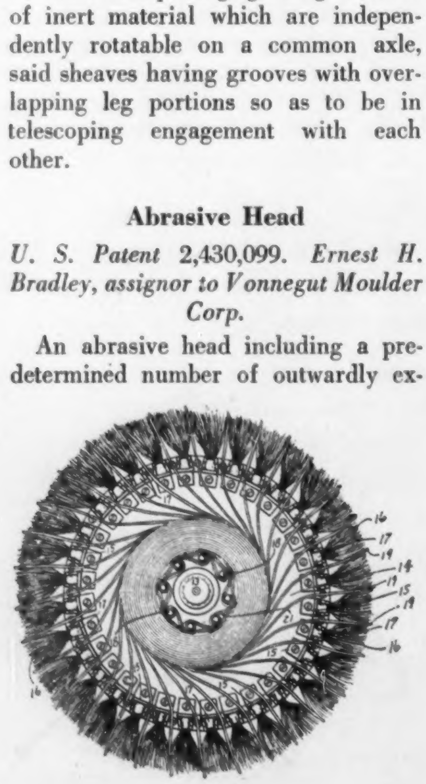


ing said metal strands through said machine comprising guiding sheaves of inert material which are independently rotatable on a common axle, said sheaves having grooves with overlapping leg portions so as to be in telescoping engagement with each other.

Abrasive Head

U. S. Patent 2,430,099. *Ernest H. Bradley, assignor to Vonnegut Moulder Corp.*

An abrasive head including a predetermined number of outwardly ex-



tending brushes spaced from each other about the periphery thereof, a plurality of abrasive strips rolled upon each other within said head with the free end of at least one of said strips extending outwardly between adjacent brushes, a support for said brushes, an annular series of anchor members less in number than said brushes and abrasive strips carried by said support inwardly of and concentrically with said brushes to provide a spool and anchor for the inner ends of said strips, and a connecting element secured to a plurality of said strips adapted to interlock with each of said anchor members.

Formation of a Strong Bond Between a Ferrous Metal Surface and an Electrodeposit of Silver

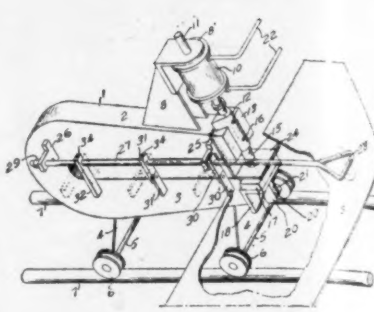
U. S. Patent 2,431,947. *William M. Martz, assignor to General Motors Corp.*

A process of producing a strongly bonded electrodeposit of silver directly onto a steel surface which includes, electrolytically cleaning the said surface in an alkaline solution, washing said cleaned steel surface, anodically treating said washed steel surface in a solution composed of approximately equal volumes of phosphoric acid (H_3PO_4) and water for from approximately 30 to 600 seconds, the acid solution being operated at a temperature from about room temperature up to 150° F. and at an anode current density of from 5 to 150 amperes per square foot, rinsing said anodically treated surface, then cyanide dipping said treated surface in an aqueous solution of an alkali metal cyanide of the class consisting of sodium cyanide and potassium cyanide for about 10 to 20 seconds, then striking a silver plate onto said surface in a silver cyanide electroplating strike solution, then electrodepositing a silver plate of desired thickness in a silver cyanide plating bath, and thereafter annealing said silver plated steel surface at a temperature within the range of approximately 400° to 1200° F. for a time within the approximate range of 30 to 120 minutes in a non-oxidizing atmosphere.

Apparatus for Forming Test Samples of Electrolytic Tin Plate

U. S. Patent 2,431,528. *Arthur Forest Wells, Jr. and Paul C. Mackley.*

Apparatus of the class described

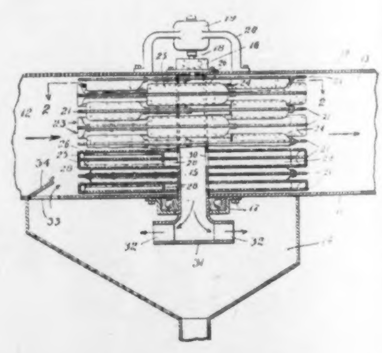


comprising a frame having arms adapted to extend above and below a strip, a punch carried by one arm, a die carried by the other, means supporting the frame for movement transversely of the strip, means operate to actuate the punch, and stop means engageable with the edge of the strip and consecutively operable to arrest movement of the frame across the strip at predetermined intervals.

Dust Collector

U. S. Patent 2,431,336. *Roland L. Lincoln, assignor to Westinghouse Electric Corp.*

A dust collector comprising a housing having a gas inlet and an outlet, a hollow hub supported for rotation in said housing between said inlet and outlet, means for rotating said hub, a plurality of discs on said hub, and a plurality of deflectors attached to opposite sides of said discs and extending outwardly from said hub, said deflect-



ors having circumferentially extending outer members, having downstream members extending from said hub to said outer members, and having upstream members extending from said hub to closely adjacent said outer members and forming gas inlet openings at said outer members, said upstream and downstream members forming gas passages therebetween extending from said openings to said hub, said hub having openings therein in alignment with said passages.

Nickel Plating

The uses for nickel deposited from electrolytic baths have become almost too numerous to mention, and depend on the unique properties of nickel, outstanding among which are the excellent resistance to corrosive materials and the range of hardnesses available. Not to be overlooked is the ease and economy with which such deposits may be obtained. The following chart attempts to simplify a complex subject. While there is some overlapping of baths and applications, this classification will cover the large majority of uses.

APPLICATION	PROTECTIVE & DECORATIVE			WEAR RESISTANCE SALVAGE	ELECTROFORMING
	DULL NICKEL	BRIGHT NICKEL	DIE CAST NICKEL		
PURPOSE	Provides a simple means for plating nickel. Control of solution less critical than other baths. Oldest and still most widely used method where bright deposits are not required.	Provides a method for producing bright deposits directly from the bath over buffed surfaces. With most baths, less preparation of the base metal is required for equivalent brightness.	This type of bath widely used for plating nickel directly on zinc-base die castings. Due to high sulfate content of these solutions, the ionization of nickel is repressed so that the deposition potential of nickel becomes electronegative to that of the zinc alloys.	Where the conditions of wear and corrosion co-exist, heavy deposits of nickel are widely used. The resistance to chemical attack of nickel, plus the wide range of hardnesses possible, provide an extremely useful technique for engineering applications.	Electroforming is used where accurate reproduction of surfaces is essential, where other methods are too costly or difficult. Possible to reproduce surface irregularities as fine as .00002 inches in width this way. Electroforming involves two steps: plating, and separating the deposit from the form.
PROPERTIES	Soft, easily buffed deposits. Bath has good throwing power, but rate of deposition is slower than for bright baths. Extra thickness must be plated to allow for removal by buffing.	Properties of the deposit may be varied over a wide range from soft to very hard. Deposits are smooth and fine grained, and rapidly deposited. Chrome may be deposited directly over the nickel without intermediate operations.	Deposits are relatively brittle and hard, and heavy deposits tend to crack and peel. Direct plates on zinc not recommended for outdoor exposure. Undercoats of .0002-3 in. of copper are advised. Deposits are not bright and must be buffed for high lustre.	Hardness of plated nickel as high as Rockwell C-45. While softer than chrome, nickel can be machined while chrome must be ground, making operations more economical. Adhesion is good, and rates of deposition are .001-.004 in. per hr., about 5 times as fast as chrome plating.	Nickel is used in place of copper because of superior hardness and wear resistance. Four to ten times the life of copper is usual. Hard, stress-free deposits are necessary for successful use of this method.
PROCEDURE	A typical bath is as follows: Nickel Sulfate 15-20 oz./gal. Ammonium Chloride 3- 6 " Boric Acid 4- 6 " Temp. 75°-85° F. 5-20 amps./sq. ft. pH 5.2-6.0. Peroxide used to control pitting.	Basic solution: Nickel Sulfate 30-45 oz./gal. Nickel Chloride 5- 9 " Boric Acid 4- 6 " To this is added addition agents to control brightness and pitting. Addition agents are the subject of patents and are available from several manufacturers. Temp. 120°-160° F. 20-100 amps./sq. ft. pH 2.5-4.5.	Typical bath: Nickel Sulfate 10-15 oz./gal. Sodium Sulfate 10-15 " Ammonium Chloride 2- 4 " Boric Acid 2- 4 " Temp. 70°-80° F. 10-35 amps./sq. ft. pH 5.6-6.2.	Many baths are used for depositing nickel for engineering uses. The following is typical: Nickel Sulfate 24 oz./gal. Boric Acid 4 " Ammonium Chloride 2-4 " pH 5.8-6.2. 50-100 amps./sq. ft. Temp. 120°-130° F. High pH favors a harder deposit.	Many baths used for electroforming. Essential requirement is a fine-grained deposit having low internal stresses. Baths listed for other applications also suitable. Preliminary cleaning steps are critical for clean separation of the deposit. Separating films of graphite, etc., usually employed.
TYPICAL USES	Suitable for small scale operations and complicated shapes. Maintenance is simple, pH being the principle control required. Unbuffed coatings are used principally for internal parts where lustre is not important. Deposits can be buffed to a high lustre.	These baths are particularly well adapted to large volume operation, providing an excellent appearance at reduced costs. Widely used in the finishing of automotive, refrigerator, hardware, and metal furniture parts.	Zinc-base die castings are widely used in automotive and appliance fields. Grills, door hardware, and dashboard trim are examples. For this type of service coatings up to .001 in. thickness are required, with about .0003 copper, finishing with .00002 in. of chrome.	Worn and corroded parts salvaging. Crankshafts, paper mill rolls, corrosion resistant valves and seats, gears, turbine blades and buckets are regularly produced by this technique.	Principal use for nickel electroforming is the production of molds for phonograph records, and for electrotypes where long runs are planned. Production of thin sheeting and screen wire are other commercial applications.
NOTES	Tanks may be rubber, pitch, or wax lined. Periodic filtration recommended to remove dirt and impurities. Same solution also usable for barrel plating.	Bright nickel baths require close control. Prevention of contamination must constantly be exercised, and continuous filtration is advised. One of the patented baths deposits an alloy of nickel and cobalt. The remainder utilize organic brighteners.	This type bath also used for plating aluminum alloys after the usual zincate dip. Alkaline baths for plating nickel direct on die castings are also available. This type bath is useful for recessed parts, as the throwing power is high.	Uniformity of plating bath conditions must be maintained for consistent results. Parts usually plated oversize a few thousandths, then machined to finish size for smooth surfaces.	Where extreme hardness of the electroformed surface may be required, a flash coating of chrome is sometimes used over the nickel. In many cases the initial deposit only is made from nickel, and this is backed up by copper, which can be deposited at a faster rate to produce the desired thickness.

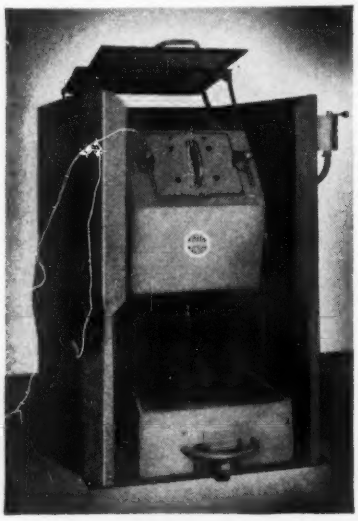
Recent Developments

New Methods, Materials and Equipment for the Metal Finishing Industries

New Roto-Finish Machine

Sturgis Products Co., Dept. MF, Sturgis, Mich.

A one compartment Roto-Finish ma-



chine for small mechanized de-burring and finishing installations is announced by the above company.

Known as the CW-22-1 Model, it has the same sturdy design and operational features of the well known CW-45-2 and CW-60-2 Machines, that permit efficient and economical processing of small parts, using the Roto-Finish Grinding, De-burring, Britehoning or Coloring Process.

The one compartment cylinder—19"x 32" I. D. is lined with replaceable kiln dried Hardwood Maple and equipped with a full size, light weight door, with newly designed molded rubber gasket, firmly held in place by rugged, fast-action cam locks. The safety guard is designed to raise and lower easily with minimum effort, it is claimed.

Standard equipment includes a forward and reversing switch with synchronized magnetic brake to facilitate loading and unloading; water attachment; including a conveniently located control valve, for adding water to the processing compartment; a $1\frac{1}{2}$ H. P. 220-440-volt, 60 cycle, 3 phase motor with gear reducer; and a swivel type, 3 point suspension hoist pan of original and efficient design for loading and unloading the processing media.

Solid Glass Blocks

Pittsburg Corning Corp., Pittsburg, Pa., Dept. MF.

Manufacture of solid glass block by the above firm has been announced by H. R. Haynes, sales manager. A wartime casualty, the solid block has been available for shipment since October 1, 1947.

Prior to the war this block had found many special uses in plating and similar operations. The blocks were used as insulating supports for acid and electrolytic tanks. Size of the solid block is 5" x 5" x $2\frac{5}{8}$".

Following are its physical properties:

Compression Strength (ultimate)—80,000 lbs. per sq. in. under uniform loading.

Modulus of Elasticity—10,000,000 lbs. per sq. inch.

Coef. of Expansion (linear)—0.0000047 per degrees F.

Weight—5.7 lbs. each.

Steel Surface Conditioners

Hanson-Van Winkle-Munning Co., Dept. MF, Matawan, N. J.

Surbrite S and *Surbright H* are developments of the above company. In short supply during the war period due to raw material restrictions, these products are again readily available.

These materials belong to the class of compounds broadly classified as acid inhibitors, that is, compounds to be added to sulfuric acid and hydrochloric acid pickling solutions. However, since they have the additional property of wetting or lowering surface tension and the ability to cause the pickled steel to develop a bright, smut-free surface, they are designated as "steel surface conditioners." The following advantages are claimed by the manufacturers:

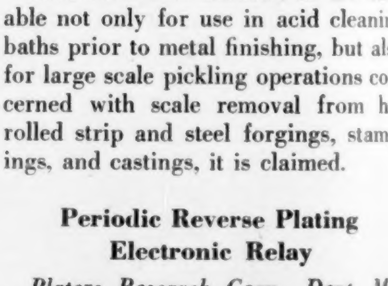
1. They save steel in that only the scale is attacked to any great extent.
2. They save acid because the acid ordinarily used in attacking the steel is not consumed.
3. Reduction of hydrogen embrittlement, which occurs as the result of the hydrogen freed by the action of the acid on steel being absorbed by the steel during the pickling operation.
4. Decreased hazard because much less spray is produced, inasmuch as the amount of hydrogen formed is small.

Surbrite S and Surbrite H are suitable not only for use in acid cleaning baths prior to metal finishing, but also for large scale pickling operations concerned with scale removal from hot rolled strip and steel forgings, stampings, and castings, it is claimed.

Periodic Reverse Plating Electronic Relay

Platers Research Corp., Dept. MF, 59 E. 4th St., New York, N. Y.

Production of a low cost electronic



relay timer for periodic reverse current plating is announced by the above firm.

The periodic reverser may be con-

nected either to a generator or rectifier. Its capacity is 10 amperes on the plating line. Plating time cycle is up to 20 seconds while reverse plating cycle time is up to 5 seconds. Any combination of direct and reverse current timing within these ranges may be obtained by simple adjustment of two control knobs.

A switch is provided to turn off periodic reverse and permit only conventional plating if desired. An additional stand-by switch is provided so that where plating is interrupted the unit remains ready to operate thus eliminating the usual warm up period required by all electronic equipment.

This small inexpensive unit will enable platers to experiment with periodic reverse plating which has aroused wide interest. The process is said to increase rate of plating, increase the density of metal deposited, improve brightness of plate, allow heavier deposits, decrease porosity and provide better metal distributions. Some of these claims have already been confirmed by various investigators, according to the manufacturer.

Platers Research Corp. also manufactures Dr. Pan's control systems for the analyses of plating solutions, brighteners for barrel nickel plating, standard reagents, and fine chemicals.

"Kube-Kut" Sawdust

Michael Wood Products, Inc., 625 Midland Ave., Dept. MF, Garfield, N. J.

The above firm is offering the metal industry a newly developed "Kube-Kut" (cube-cut) sawdust intended pri-

marily for drying and polishing of metals and other materials, with all of the advantages commonly recognized in ordinary types of wood flour, plus the added advantages so obvious in such a type of cut wood flour.

"Kube-Kut" (this term is a copyrighted expression characteristic of cube-cut wood flour intended for drying and polishing purposes) is specially made from green Maple sawdust at logging operations, properly "screened" (mechanically sifted to insure uniformity in particle size), elimination of bark, and dried in a uniformly heated rotary dryer and again screened to obviate fine particles.

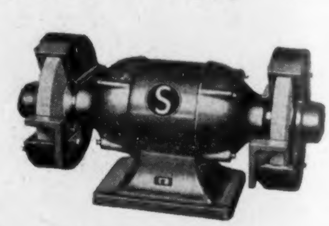
The absence of the elongated slivers makes this material easy to shake free from products treated with it, as in the case of drying and polishing operations. "Kube-Kut" does not pulverize readily in tumbling processes, creating no films on the surface of the materials dried and polished, it is claimed. To further insure clean, dust-free "Kube-Kut" sawdust, the burlap bags are cleaned by means of compressed air before filling. "Kube-Kut" sawdust is available in a variety of meshes to suit individual needs, and is packed in 50 lb. bags.

Illustration shows the new "Kube-Kut" sawdust compared with ordinary material.

Bench Grinder

The Standard Electrical Tool Co., 2503 River Road, Dept. MF, Cincinnati 4, O.

This bench grinder is equipped with 1/3 H. P. 3600 R.P.M. totally enclosed motor for 110 volt, single phase, 50 or 60 cycle and can be furnished to order for 220 volt single phase, and ten



feet of three conductor No. 16 rubber covered cable with two prong attachment plug, one wire for ground. The safety type enclosed guards each have exhaust outlet, adjustable spark breaker and work rest. A double pole toggle switch conveniently located in the base. The machine is furnished with two 6″x ¾″x ½″ grinding wheels. The distance between wheels is 16″ and the

height to center of spindle is $6\frac{3}{4}''$. Net weight 60 lbs.

The price of this machine complete is $49.50. Safety glass eye shields are available at $3.00 per pair and to order, can be assembled with a floor pedestal at $21.50. Pedestal has tool tray with removable water pot.

Lead Anodes Equipped with Cast Copper Hook

Division Lead Company, 836 W. Kinzie Street, Chicago 22, Ill., Dept. MF.

Development of cast copper anode hooks, which are claimed to be the first ever used, is announced by the above firm.

Used on Divco 71-Point Lead Anodes, the cast copper hooks double the current carrying capacity and further increase the great overall efficiency made possible by the 71 throwing edges, it is claimed.

The cast design retains the special shape which facilitates handling as well as assures efficient conductance and secure bonding to the anode body.

Black Finish on Zinc and Cadmium

The Mitchell-Bradford Chemical Company, 2446 Main Street, Dept. MF, Stratford, Conn.

Announcement is made of a new process for applying to zinc plate, zinc alloys (die castings), and cadmium plate, an attractive black finish.

This finish is applied by immersion in the BLACK MAGIC Zinc Black solution, resulting in a chemical reaction with the zinc or cadmium surface to produce a glossy black finish. The reaction is quite rapid, resulting in a very short immersion time of from one to two minutes for zinc and zinc alloys; or three to five minutes for cadmium plate.

The resultant finish is claimed to

have many desirable characteristics, included in which are the following:

(1) Abrasion resistance: It is now being used as a finish on moving parts, or parts which are subject to constant abrasion and pressure.

(2) Resistance to most alkalis, acids, and organic solvents.

(3) Attractive glossy black finish: Adds eye appeal to the finished product at low cost of application. It is now being used on zinc die cast toys, machine parts, recorders, camera parts, etc.

(4) Tenacious bond for subsequent application of paints and enamels: As short an immersion of 30 seconds in the BLACK MAGIC Zinc Black solution has provided a satisfactory paint bond. Silk screening of trade names and slogans on the Zinc Black finish has also worked well in the field on production runs.

(5) Minimum tank equipment required: A plain steel tank is used for the processing tank. If cleaning and rinsing facilities are already available, it is only necessary to install one steel tank for the BLACK MAGIC Zinc Black Solution.

Finished samples are available upon request and manufacturers are invited to send samples of their own items for the application of BLACK MAGIC in order to see and evaluate the finish for their own requirements.

Acid-Proof Brush

The Eraser Company, Inc., Syracuse 2, N. Y., Dept. MF.

Developed for use by industrial users of acids for cleaning operations,

this new acid-proof brush is available.

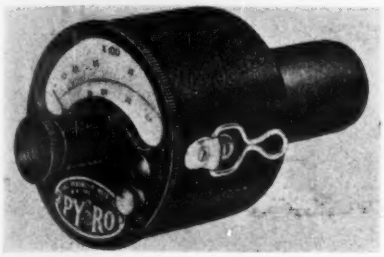
The brush is made with a soft tuft of "FybRglass" solidly imbedded in a wood handle of conventional shape. When wet, the FybRglass becomes soft and pliable in the same manner as ordinary brushes, it is claimed. The

brush may be used in any acid that does not affect glass—nitric acid, soldering fluxes, chromic acid, chloride of iron, etc. Any manufacturer using acids for cleaning purposes may secure a brush on a trial basis. The acid brush illustrated measures 3" in width, 3/8" in thickness and has bristles extending 2½" from the handle and retails for $10.00. Other sizes of acid-proof brushes can be made to meet special requirements.

Radiation Pyrometer

Pyrometer Instrument Co., Dept. MF, 103 Lafayette St., N.Y.C.

The PYRO Radiation Pyrometer has been designed to meet the requirements for a quick and accurate method to



determine temperatures above 1000°F. by thermo-electric principles. This new instrument is completely self-contained weighs less than two pounds, is direct reading and requires absolutely no outside connections, lead wires, batteries or other accessories. PYRO Radiation is completely automatic in its operation and requires no skill or previous instruction in its use, according to the manufacturer. It is only necessary to sight the instrument at the object being measured and read the temperature on its wide direct reading scale. The special indicator locking device holds the pointer at the reading obtained until a button is pushed permitting the indicator to return to is zero position.

The operation of the NEW PYRO Radiation is based upon the established laws of radiant heat. A very sensitive vacuum thermocouple within the instrument is sighted at the object being measured and the resultant electromotive force operates a galvanometer calibrated in direct degrees of temperature. The instrument is constructed in a steel housing making it not only rugged and durable but also immune to external magnetic and electrical influences, it is claimed.

PYRO Radiation finds application wherever spot temperatures above

1000°F. are to be measured quickly and accurately such as in all types of furnaces, forgings, fire boxes, kilns, retorts, etc.

New Odorless, Clean Inhibitor for Sulphuric and Hydrochloric Acids

Enthone, Inc., 442 Elm Street, New Haven, Conn., Dept. MF.

The development of Enthone Inhibitor No. 9 has been announced. This is a liquid inhibitor that dissolves readily in acid solutions. The manufacturer states that this inhibitor is very useful where exhaust ventilation is not available, as it is completely odorless. Another feature is its inhibiting action in both hydrochloric and sulphuric acid solutions. In solutions of both hydrochloric and sulphuric acids, the inhibiting action is over 90% and in some cases ranging up to 98%, it is claimed.

The inhibitor dissolves cleanly in the acid solution leaving no sludge or residue, as do many inhibitors. Acid solutions, therefore, are easily rinsed off the work.

The inhibitor is available as a liquid which dissolves very readily in the pickling solutions. The inhibitor is suitable for use in both cold and hot pickles. Bright surfaces are left bright after pickling operations, the result being an improved product when simple pickling is done, or a better base for plating or hot coating.

Safety Goggles

American Optical Co., Southbridge, Mass., Dept. MF.

A new lightweight, comfortable safety goggle featuring an all-plastic

frame with a single plastic acetate lens which provides maximum vision is announced by the above firm.

The new AO 607 safety goggle is recommended for wear directly over eyes or over spectacles for frontal protection against flying particles on jobs such as machine work, hand tool operations, chemical and physical laboratory work, bottling operations, spot welding and light grinding, chipping and riveting.

The design of the durable brown plastic frame is such that it provides unobstructed side vision, excellent frontal protection and smart appearance. No metal touches the skin.

The single plastic acetate lens in green or white color, conforming to high safety standards, is easily replaceable.

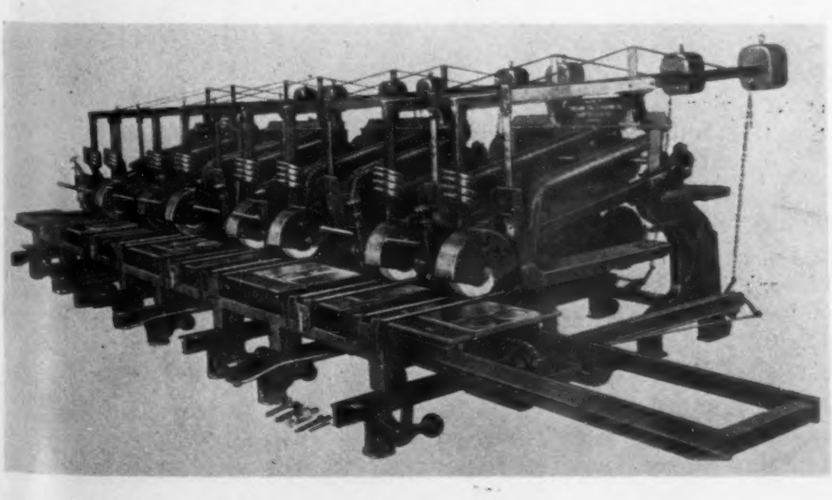
The metal temples, enclosed in acetate to prevent corrosion, are easily adjusted and hold the goggles snugly without irritation, it is claimed.

Each goggle is supplied with a leatherette case.

Multiple Spindle Grinding and Polishing Machine

Excelsior Tool and Machine Co., 3100 Ridge Ave., Dept. MF, East St. Louis, Mo.

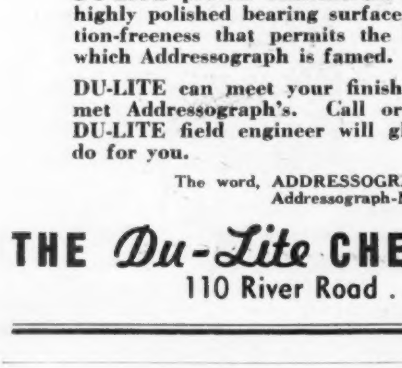
Recently announced by the above firm is a new type multiple spindle high-speed ball bearing grinding and polishing machine. These machines are designed for automatic polishing and grinding of flat and semi-flat surfaces. Illustrated is a model being used for finishing stove tops. The improved design of these machines is the result of many years experience in the field, and incorporates high speed grinding wheels which are claimed to cut faster, last longer, and generate less heat, resulting in fine finishing at low cost. Included in the equipment provided with these machines are heavy safety wheel hoods and an efficient dust collecting system, as well as totally enclosed dust proof ball bearings, fan cooled motors, magnetic swtiches, and push button controls.



Plating Barrel

The Wico Metal Products Company of 23142 Sherwood Ave., Van Dyke, Mich., Dept. MF.

This company announces the development of a new line of plating barrels, incorporating many exclusive features, including a spiral type plating cylinder without a cover. It unloads automatically by changing the direction of rotation of the cylinders. It has the least number of working parts of any plating barrel being marketed today, it is claimed. The barrel and

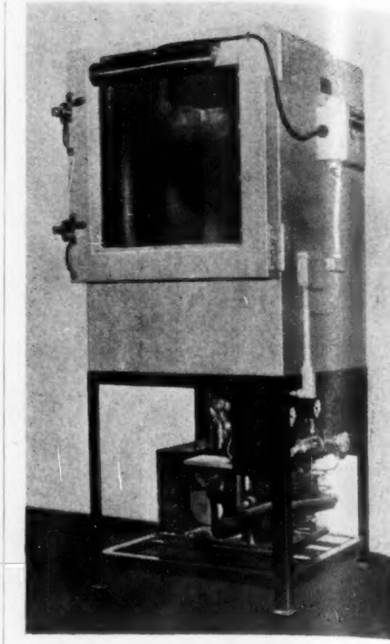


drive are a self contained unit, therefore it can be used for cleaning and carried through the complete plating cycle. The spiral shaped cylinder adds many desirable features. Nesting is avoided as they are automatically broken up when they cascade over the spiral giving a uniform plate in less time than ordinary plating barrels, according to the above firm.

Temperature and Humidity Unit

Tenney Engineering Co., 26 Ave. B, Newark 5, N. J., Dept. MF.

A new, self-contained laboratory testing unit has just been announced by the above company, pioneers in the development and manufacture of automatic temperature, humidity and pressure control equipment, stratosphere



chambers, refrigeration and related types of equipment.

The announcement states the unit has facilities for accurately controlling temperature and relative humidity within a working chamber having a clear space 18" x 18" x 18". The manufacturer claims that the temperature within the chamber in the regular model can be varied over a range from plus 20 degrees F. to plus 200 degrees F. An extension of this temperature range is available when desirable. The maximum rate of temperature change is 20 degrees F. per minute. When the desired temperature is reached, it can be maintained within a tolerance of plus or minus 2 degrees F, it is claimed.

The relative humidity can be controlled above or below ambient, at a minimum wet-bulb temperature of 33 degrees F. An extended surface dry-expansion coil is used to lower the temperature or relative humidity, independently.

Standard models are equipped for operation on 115 volt, 60 cycle, single phase current, but may be had to operate on 230 volts when desired.

Close control is provided through accurately calibrated thermostatic elements and dial-type temperature indicators.

Electroplating Pulse Selector

Hill Cross Co., 22 Spruce St., New York 7, N. Y., Dept. MF.

Designed to have universal application in electroplating production or research, the Hill Cross Pulse Selector permits periodic switching of a con-

stant direct current. Two synchronous-motor timers are coordinated to actuate instantaneous changeover between paired power circuits. Each timer may be set, individually and on a permanently calibrated dial, to close its circuit for any time between 3/4 and 15 seconds. A toggle switch turns the unit on and off, another reverses the direction of alternate pulses, and a third selects continuous or pulsing current. Terminals are provided for entering one of the power circuits. A resistor or rheostat may be connected across them to make alternate pulses at higher or lower current, in either direction. With the terminals open the unit operates as a periodic interrupter. By connecting a transformer or variable frequency alternator, still other combinations are possible.

The smallest unit, rated 50 Amperes at 15 Volts D.C., is enclosed in a wall-mounting steel cabinet 14"x14"x5" with access to the timers and switches through a small door on the front. Bus from the power source connects at the top and the controlled power appears on bus terminals at the bottom. External circuit terminals are at one side and the 110 Volt 60 cycle supply enters on the other. Similar units are supplied with an additional timer to shut off current at a preset interval after starting by external push-button. Various timing ranges and any higher current capacity can be furnished.

Adhesive Gauze Tape for Worker's Fingers

Modern First Aid Necessities Co., 737 W. Randolph St., Chicago, Ill., Dept. MF.

Designed to protect fingers or other parts of the hand from painful skin

burns, bruises and other injuries, a special adhesive gauze tape is announced for use by factory workers in practically every field. Called *Gauztape*, it is actually a combination of gauze and tape, and is so treated that it adheres only to itself without leaving gummy deposits on the skin. It is oil resistant. Strips of the tape may be applied to the fingers in a jiffy, thus helping to solve the glove problem. In most instances, as soon as holes are worn in glove fingers, the gloves are discarded. With *Gauztape*, only the parts of the hand to be protected are taped, and because of the low cost of each roll, new protectors may be applied several times a day if necessary. This is advantageous in cases where the items being handled must be kept clean. The gauze provides a comfortable protective cushion and because of its adhesive qualities, the wrappings are claimed to remain securely fixed.

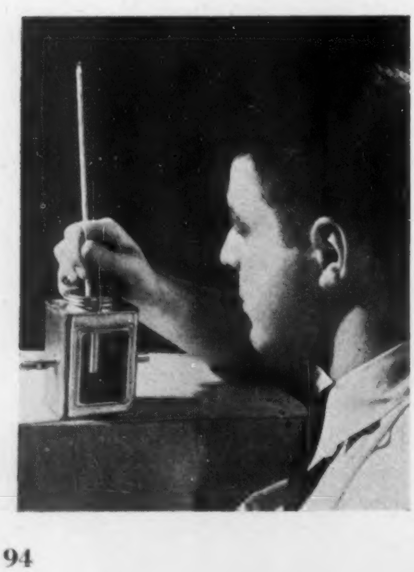
The material is supplied in rolls 1 inch wide and 15 yards long, 2 inches wide and 10 yards long, or cut to size upon request.

Dewpoint Apparatus

Pittsburgh Lectrodryer Corp., Dept. MF, P. O. Box 1766, Pittsburgh, Pa.

To meet a growing need in a wide range of industrial and research fields

for a simple, inexpensive device for measuring the moisture content of air



and gases at approximately atmospheric pressure, this company, manufacturer of dehumidification equipment, is now manufacturing a dewpoint apparatus.

The company's research department points out that the results obtained with the apparatus compare satisfactorily with more complicated and expensive methods for the determination of moisture content.

The Lectrodryer device is less likely to result in error than the wet and dry bulb method of moisture determination, particularly at dewpoints below zero degree C., it is claimed.

Selling at less than $20, the apparatus consists of: 1—An outer container with inlet and outlet connections and a glass window. 2—An inner container having a highly polished outer surface visible through the window. 3—A thermometer.

To determine the dewpoint temperature a small sample of the gas to be tested is passed through the outer container while a mixture of crushed dry ice and acetone is stirred in the inner container. The stirring is done with the thermometer. As the temperature drops as a result of the stirring the polished surface of the inner compartment is closely observed through the glass window. At the first indication of dew or moisture on the polished surface of the inner container the temperature is read from the thermometer. This dewpoint temperature is a reasonable accurate indication of the moisture content of the gas or air under test.

Use of the acetone and dry ice mixture makes possible the quick checking of dewpoints as low as minus 76 degrees C.

Users of the device are furnished complete directions to insure the best possible results.

Corrosion Resistant Gearless Pumps

Eco Engineering Co., 12 *New York Ave., Newark* 1, *N. J. Dept. MF.*

A new line of gearless pumps for general industrial use, has just been announced by the above company.

Based on the successful principle of gearless pumps, which have been in use in the marine field for the past twelve years, the newly designed pumps include several special features and improvements which are claimed to make them ideal for the handling of practically all types of liquids. Chief among the improvements is their new double impeller design which gives a strong flow against pressure.

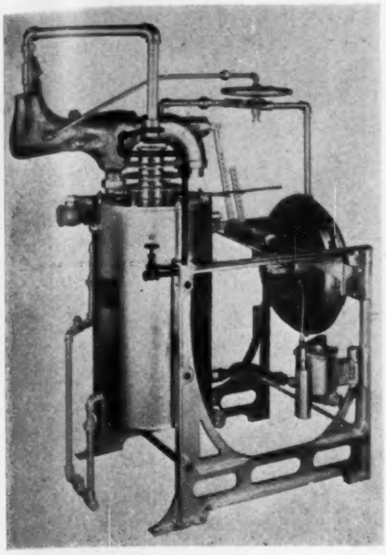
Bodies are available in stainless steel, monel and bronze to meet a wide range of industrial conditions. Body of pump is stated by the manufacturer to last indefinitely. Every wearing part of the pump can be replaced, if necessary. All pump parts which come in contact with the liquid handled can be adapted for that special purpose.

These new line of pumps are said to be adaptable for nearly every type of liquid handling including acids, solvents, oils, etc. They are available in ¼" and ½" sizes, capacities from one to twelve gals. per minute varying with pump speeds and pressures.

Low-Cost-Gas Generator

Vapofier Corporation, 10316 S. Throop St., Chicago 43, Ill., Dept. MF.

Latest improvements of Vapofier, a compact unit producing safe, low-cost gas from fuel oil for all types of in-



dustrial ovens and furnaces—are foolproof alignment of parts, improved appearance and less weight, it is claimed. All of these advantages are gained by a new streamlined, cast-aluminum chassis, which facilitates periodic attention.

Used as a gas "standby" because of its quick switchover to gas without interruption of flame or change of flame quality, users report reduced fuel costs, many reporting savings up to 50 per cent over manufactured gas, according to the manufacturer. Now used in 84 industries, Vapofier automatically maintains constant pressure and air-gas ratios from a reducting to an oxidizing flame, with few moving parts.

Transparent Oxide Coat on Aluminum

Technical Processes Division of Colonial Alloys Company, Philadelphia 29, Penna., Dept. MF.

The Anonizing Process is a simple immersion method of protecting aluminum surfaces and yet maintaining its natural color. Aluminum that has been etched or mechanically or electrolytically or chemically polished as well as aluminum as furnished by the mill, can be treated by this process without noticeably changing the appearance, it is claimed.

This coating resembles an anodized coat (aluminum oxide) but it is more compact and it is quite protective, at the same time being transparent, according to the above firm.

Practically all of the alloys of aluminum respond to this treatment. The coating resembles a clear glaze, although it is not brittle. On some alloys, such as those containing substantial amounts of silicon, the surface of the metal darkens slightly, but after it is coated it has a glazed-china effect.

Anonized coats are claimed to have good abrasion resistance and resistance to smudging, oxidizing, fingermarks, ordinary handling and high temperatures.

The process consists of immersing the cleaned aluminum into the hot Anonizing solution for a few seconds to a few minutes, then rinsing. The equipment can be ordinary steel and many items can be handled in batch, as in baskets.

Many articles can be treated as low as one-fifth cent per square foot of area processed. (estimated cost of Anonizing solution) according to the firm.

Another feature of this transparent protective coating is that it is an excellent base for paints and lacquers. Sample parts will be processed without charge.

Threadless Malleable Pipe Fittings

Stanley G. Flagg & Company, Inc., of Philadelphia, Pa., Dept. MF.

Flagg-Flow malleable pipe fittings, the first threadless malleable fittings made for brazed pipe joints, have been introduced to industry by the above firm.

In announcing the new development the company claims that the revolutionary threadless fitting simplifies any piping layout and makes it possible to join steel or wrought iron pipe without threads and without welding by a brazing method any competent pipe fitter can use.

Claimed to be the first joint ever produced that opens the way to reducing the wall thickness and weight of pipe, it enables the use of plain end pipe, thereby eliminating thread cutting which otherwise would weaken the pipe wall by reducing its thickness. These fittings also afford 30 per cent less weight than the same kind and size of threaded fitting, because of the absence of the chamber, and makes possible the use of lighter weight pipe

throughout the system, according to the manufacturer.

Designed for brazing to standard black steel or wrought iron pipe, the new fittings are currently made in sizes up to and including two inches, which comprise a large portion of the piping now installed.

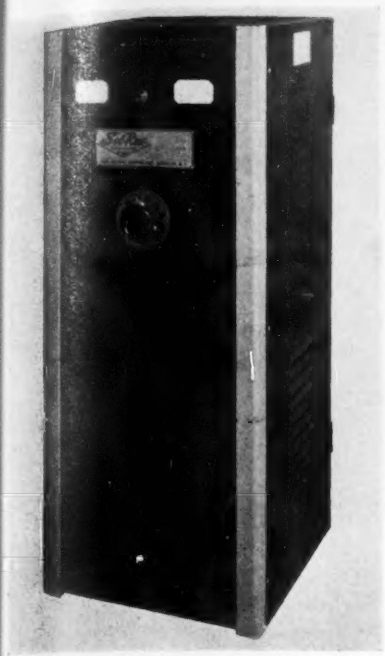
Complete freedom in piping layout is claimed through use of Flagg-Flow joints, as extensive application tests have demonstrated there is no trouble with tight, inaccessible spaces, or with distortion strains in forcing fittings to face properly by wrenching them into position.

12 Volt Rectifier for Barrel Plating

Bart - Messing Corp., 45 Morgan Ave., Dept. MF, Brooklyn 6, N. Y.

The Bart-Messing Corp. engineering staff has just designed a 750 ampere, 12 volts selenium rectifier that was specifically made for the barrel-plating industry. Barrel platers can now use the exact type of rectifier for their specific requirements without being obliged to compromise with larger and more expensive units.

This unit is equipped with tap switch control from 9 to 12 volts, for use in



the operation of one or more barrels, depending on the size and load. It is economically priced and a minimum expense to operate, it is claimed, with a full load operating efficiency of 77%.

Conservatively designed selenium elements have approximately 310 square inches of rectifying area per 100 amperes, triple impregnated for corrosion protection.

Equipped with ball bearing fan, large Weston Meters and Shunt, and doors for easy accessibility, the specially engineered, heat treated transformer, will withstand high temperatures and corrosive atmosphere, according to the manufacturer.

Engineered for positive protection against ventilation restriction, the rectifier will automatically shut off if air intake is blocked.

The cabinet is made of sturdy sheet metal, mounted on ball-bearing casters for quick mobility. Dimensions: 56" x 22" x 24". Input 200-220 volts 3 phase 60 cycles or 400-440 volts 3 phase 60 cycles.

Business Items

Dr. Kahan Joins Lea

The Lea Manufacturing Company is pleased to announce that *Dr. George J. Kahan* joined The Lea Technical Staff January 1, 1948 to conduct electrochemical research work.

Dr. Kahan has been known recently for his activity as Project Director of the A. E. S. Research Project No. 4 on *"The Effect of Surface Finishing on the Protective Value of Electrodeposited Coatings."* He will continue as Project Director until the completion of that Project.

Dr. Kahan received his Degree as Doctor of Natural Science at the University of Prague, Czechoslovakia. He later studied Polarography under the internationally known *Dr. Heyrovsky* in Prague for two years, and subsequently for three years at the University of Minnesota.

In 1939 he joined the Research Staff of the *Chromium Corporation of America.*

Since 1941, Dr. Kahan has been a member of the Research Staff of the *U. S. Time Corporation* and worked on chemical and materiel problems.

Course in Electroplating

The Rhode Island State College has announced that a course in electroplating will be given in Providence, starting Feb. 19, 1948. The course is entitled *"Introduction To The Field of Electroplating,"* and will cover 48 hours of instruction. This course is the first in a series planned as a result of a request from the *Providence-Attleboro Branch* of the *American Electroplaters Society*. The purpose of these courses is to acquaint the prospective and present personnel in this important Rhode Island industry with the basic

fundamentals of Chemistry and Electricity which are necessary for professional competence in this field.

The classes will be held at the Rhode Island College of Education Building, Providence 8, R. I. Students who satisfactorily complete the course will be granted a certificate of competence by the Rhode Island State College.

Austin Fletcher Joins Enthone, Inc.

Austin F. Fletcher has been appointed Sales Engineer for *Enthone, Inc.*, 442 Elm St., New Haven, Conn.

Mr. Fletcher will service Central and Western New York State including Binghamton, Syracuse and Rochester.

Mr. Fletcher received his education in New Jersey and studied electroplating at *Mechanics Institute* in Newark. He started in the plating industry in 1925 with the *Elevator Supply Co.*, Hoboken. For several years, he was a chemist with *Superior Metal Co.*, Bethlehem, Pa. From 1931 to the date of joining Enthone, he was plating superintendent for *Brewer Titchener Corp.*, Binghamton, N. Y.

Austin Fletcher

Mr. Fletcher has a wide acquaintance in the electroplating industry being an active member of the A.E.S. He was Vice President of the *Newark Branch* of the *A.E.S.* and was Supreme Vice President of the Society. He was one of the founders of the Binghamton Branch which later became the Syracuse Branch.

Mr. Fletcher will sell and service Enthone products for the metal finishing industry in his territory.

Du Pont Promotes Baker

The du Pont Company announced the promotion of *Samuel G. Baker* to general manager of its Electrochemicals Department. Mr. Baker had been assistant general manager of the department he now heads.

Mr. Baker succeeds *F. S. MacGregor* whose retirement after a successful career of 31 years was also announced.

Mr. Baker started working for the company in 1923. He left the company six months later, but, after being graduated from the University of Washington with a bachelor of science degree in chemical engineering, he returned in 1925 as a chemist at the Eastern Laboratory and the Repauno Works, Gibbstown, N. J.

In 1933, Mr. Baker entered the Slaes Division, and four years later, was made director of domestic sales, and later of general sales, for the High Explosives Manufacturing Division.

In 1943, Mr. Baker joined the Electrochemicals Department as director of the Electroplating Division, becom-

ing assistant general manager of the Electrochemicals Department in 1945. He is 45 years old and a native of Tacoma, Wash.

T. G. Digges Succeeds Dr. D. J. McAdam at National Bureau of Standards

Thomas G. Digges has been appointed chief of the Thermal Metallurgy Section of the *National Bureau of Standards,* according to an announcement by *Dr. E. U. Condon,* Director of the Bureau. He succeeds *D. J. McAdam,* who has been chief of the section since 1930. Dr. McAdam retired on August 31, 1947.

Mr. Digges has been a member of the Metallurgy Division since January 1920. His studies on machinability, tool steels, and cutting tools, and his work on thermal analysis and critical-cooling rates of high-purity alloys of iron and carbon established his reputation as a metallurgist. During World War II, at the request of the National Defense Research Committee, he directed an investigation of the use of boron as a substitute for strategic alloying elements to improve the properties of steel, and, at the request of the Office of Production Research and Development he also directed an investigation of the decarburization which occurred during the manufacture of alloy steel tubing used in aircraft. This wartime work on the practical aspects of the use of boron in steel demonstrated the lack of basic information on the mechanism of the action of boron, and an investigation in this field is now in progress at the Bureau.

His technical publications have been divided between the Bureau's *Journal of Research* and outside publications, including *Transactions, American Society for Metals; Transactions, American Society of Mechanical Engineers; Metals and Alloys;* and *Metal Progress.* He received his bachelor of science degree from the George Washington University in 1926. He is an active member of the American Society for Metals, has served on the Society's Publications Committee, and is a past chairman of the Washington Chapter.

Thomas G. Digges

Metal Processing Expands

Metal Processing Co., 2344 W. Harrison St., Chicago, Ill. has expanded their operations by purchasing the A-1 Plating Works, 2940 West Lake St., Chicago 12, Ill. New plating equipment is being installed in the Lake St. plant for volume production of zinc die castings, also brass and steel parts. The McGean Bright Nickel Process and the Hanson-Van Winkle-Munning Amine-type Bright Copper will be used. Extensive polishing and buffing facilities are presently provided at the Lake St. plant.

Pennsalt Names Flourine Product Supervisor

James McWhirter has been placed in charge of Fluorine Product Process Development and Manufacture for the *Pennsylvania Salt Manufacturing Company,* it was announced by *Y. F. Hard-*

castle, Vice-President in Charge of Manufacturing.

Mr. McWhirter, Superintendent of Pennsalt's Natrona, Pa., plant for the past two years, will direct all phases of Pennsalt's growing activities in fluorine product manufacturing, temporarily from the Easton, Pa., plant, Mr. Hardcastle said.

Before joining Pennsalt as a chemical engineer in August, 1945, Mr. McWhirter had been superintendent of plants in Detroit and Cleveland for the *General Chemical Company.* He became Superintendent of the Pennsalt Natrona plant on Jan. 1, 1946.

Mr. McWhirter, a native of Scotland, came to this country when he was three. He earned his B. S. in Chemistry at Middleburg College and M. S. in Chemistry at New York University.

Mr. Hardcastle announced that *Gail E. Barr,* who joined Pennsalt in 1912, has been named Acting Superintendent of the Natrona plant. Mr. Barr has been Production Supervisor at Natrona since Nov. 30, 1943.

Vickers Succeeds Selenium Corp.

The *Selenium Corporation of America* has been voluntarily dissolved as of December 31, 1947, and succeeded by *Vickers, Incorporated.* All unfilled orders for the account of Selenium Corp. of America as of December 31, 1947 will be accepted and paid for by Vickers Inc. Correspondence should be addressed to: Vickers Inc., 2160 East Imperial Highway, El Segundo, California.

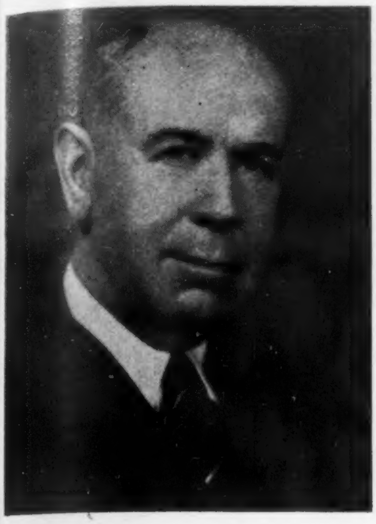
The eight representatives—*J. B. Ford Division* of *Wyandotte Chemicals Corporation*—shown above, recently received gold watches in recognition of their 25 years of service to the Company. They are, first row left to right: *Edward J. Wiley,* Springfield, Ill.; *Marlin T. Large,* Salt Lake City; *Carl W. Lange,* Grand Rapids; *Elsie Wieduwilt,* secretary, Philadelphia; *Rose Lindemann,* secretary, Wyandotte; *Wilfred B. Smith,* Providence; *S. V. Alexander,* Louisville, and *Clayton C. Cameron,* Detroit.

Carter B. Robinson, Vice President in Charge of Sales J. B. Ford Division, was toastmaster at the 1947 Service Award Banquet and is seen in the center of the second row. On Mr. Robinson's right is *E. M. Ford,* President of Wyandotte Chemicals. On his left is *W. F. Torrey,* Senior Vice President.

The annual Service Award Banquet of the Wyandotte organization was attended by nearly 500 guests. *Dr. Thomas H. Vaughn,* Director of Research was not able to attend as he was in Stockholm, Sweden.

Thomas C. Bradford Promoted by Anderson Oil

Thomas C. Bradford of Worcester, Mass. has been appointed to the posi-



Thomas C. Bradford

tion of field technical engineer by *The Anderson Oil Company* of Portland, Conn., makers of Lusol coolant and Rustavoid preservatives. Mr. Bradford has twenty years experience in the industrial oil and tool industry. He has represented The Anderson Oil Company in the New England area since 1938, during which time he has been an active member of the American Society of Tool Engineers, American Society for Metals and the Army Ordnance Association.

Dr. Thomas P. May Joins International Nickel

Dr. Thomas P. May has joined the Corrosion Engineering Section of the Development and Research Division of *The International Nickel Company, Inc.*, at New York, it was announced by *T. H. Wickenden*, Manager of the Division.

Formerly, since 1940, Dr. May was with the Chemistry Division of the U. S. Naval Research Laboratory in Washington, D. C., where he served as Head of the Corrosion Section. He received a Bachelor of Chemical Engineering degree from the Catholic University, Washington, D. C., in 1932, a Master of Science degree in Chemistry in 1935 and a Doctor of Philosophy degree in 1940.

Dr. May is a member of the American Chemical Society, the Electrochemical Society and the National Association of Corrosion Engineers. He is the author of several technical papers.

Wilson Named Pennsalt Safety Co-ordinator

Vance N. Wilson has been appointed Safety Co-ordinator for the *Pennsylvania Salt Manufacturing Company*, it was announced by *Frederick C. Abbott*, Manager of Personnel and Labor Relations.

Mr. Wilson, a graduate of the University of Michigan with a degree in economics, joined Pennsalt in February, 1941. He enlisted in the navy early in 1942 and saw service in both the Atlantic and Pacific areas.

Upon his return to Pennsalt in June, 1946, Mr. Wilson was named Supervisor in charge of tank cars in the Traffic Department.

Le Verne Verzier Joins Lupomatic

Le Verne Verzier has joined *Lupomatic Industries, Inc.*, in the capacity of Director of Development, it has recently been announced by *Mr. Charles W. Yerger*, President.

Mr. Verzier, a graduate of Rensselaer Polytechnic Institute and former Chief Chemist of *Lea Mfg. Company*, brings Lupomatic a wealth of research and practical experience in abrasive compounds for finishing both in the laboratory and in the field.

Mr. Yerger states that the chief function of Mr. Verzier will be to develop the science of tumbling to meet the increasing demand for technical equipment of this type. This work had been

done previously by *Mr. Joseph Lupo*, who is no longer associated with the company.

Mr. Verzier is a member of the American Chemical Society, Electrochemical Society and the American Electroplaters Society, as well as a professional Chemical Engineer licensed by the State of Connecticut.

Wyandotte Chemicals Advances Weller to Direector of Market Research

Paul Weller, effective December 1, was appointed Director of Market Research of *Wyandotte Chemicals Corporation*.

Carter B. Robinson, Vice President in Charge of Sales, J. B. Ford Division announces: "Wyandotte Chemicals predicated their now rapidly progressing $25,000,000 Expansion Program on extensive market research. We know that Paul Weller, who has been directing the work of the Department since last March, will successfullv expand these activities."

Mr. Weller, who has completed graduate work at Ohio State University in Business Administration, has had engineering experience with *Goodyear Tire and Rubber Company*, and has compiled market research statistics for another national organization. Under his direction the charting of trends and forecasts for the industries using spe-

Paul Weller

cialized alkalies, cleaning and washing compounds is being greatly expanded for the 16 major industries served by Wyandotte Chemicals Corporation.

Brown Expands Activities in Rocky Mt. Area

Effective January 1, the *Brown Instrument Company* expanded its sales and service activities in the Rocky Mountain area by establishing permanent sales and service representation at 400 Broadway, Denver, Colo., and 437 Atlas Building, 36½ West Second South, Salt Lake City, Utah, it was announced by *William H. Steinkamp*, field sales manager of the industrial division of *Minneapolis-Honeywell Regulator Company*.

Donald Larsen has been placed in charge of Denver industrial sales and *George Winslow*, formerly industrial service manager at Detroit, will handle similar duties in Salt Lake City, where he will work with *Eldon Richardson*, district manager.

The areas to be covered by the Denver branch, said Steinkamp, will inclcude all Colorado, Wyoming and Western Nebraska.

The Salt Lake City district will cover all of Utah, Southern Idaho and Western Nevada.

Phillips Manufacturing Company Appoints Mr. A. Otto Miller

As part of a long range expansion program, *Phillips Manufacturing Company, Chicago, Ill.*, announces the appointment of *Mr. A. Otto Miller* as Sales Engineer for the state of Indiana.

A. Otto Miller

Phillips Manufacturing Company is particularly fortunate in its association with Mr. Miller because of his many years of service in the vapor degreasing and metal cleaning industry.

Mr. Miller attended Cornell University, Ithaca, New York, and was previously associated with *Detrex Manufacturing Company*.

Woodruff Appointed at Udylite

Galen S. Woodruff has been appointed sales engineer in the Cleveland office of *Udylite Corporation*, according to an announcement by *L. V. Nagle*, vice president and sales manager.

Mr. Woodruff comes to Udylite from

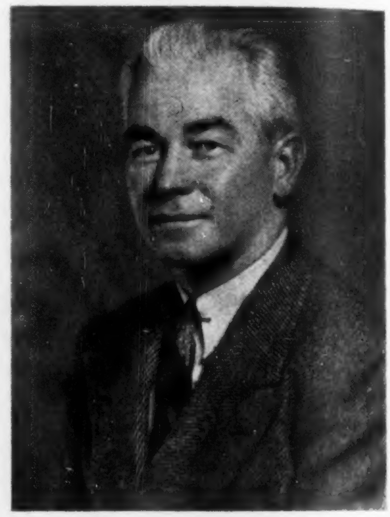
Galen S. Woodruff

Lincoln Industries where he was a foreman plater. He has a broad industrial background, and in 1945-46 served in the U. S. Navy.

Buckeye Products Appoints Lowell Fisher

Lowell S. Fisher, Indianapolis, Ind., represents *The Buckeye Products Company*, Cincinnati 16, Ohio, in Central Indiana, handling their complete line of SPEEDIE Buffing and Polishing Compositions. With more than twenty-four years experience in the metal finishing industry, Fisher is well qualified to engineer the many and varied types of problems faced by both job and production shops today. Fisher saw service in World War I and has taken an active part in veterans' organizations in Indianapolis.

In the quarter century he has served



Lowell S. Fisher

in both shop and field, Mr. Fisher has gained a particular insight enabling him to work out buffing and polishing problems, and to recommend the correct material for every type of metal, rubber, hard wood and plastics job. With SPEEDIE Compounds being available in the liquid form as well as the conventional bar type, The Buckeye Products Company offers every type of composition for all buffing and polishing operations.

Roger Gay Elected N. A. M. Director

During the recent 52nd Annual Congress of American Industry at the Waldorf-Astoria in New York City, the National Association of Manufacturers elected *Roger E. Gay* of Bristol, Conn., as one of the two directors of the association from that state.

Mr. Gay is president of *The Bristol Brass Corporation*, long-established

Roger E. Gay

Naugatuck Valley brass mill. He has been active in N. A. M. affairs for some years past.

Mitchell-Bradford Appoints Kahle

The Mitchell - Bradford Chemical Company, 2446 *Main Street, Stratford, Conn.*, has announced the appointment of *George F. Kahle* as Mid-Western Regional Director, with offices at 111 West Jackson Boulevard, Chicago, Illinois.

Mr. Kahle is a graduate chemical engineer from *Illinois Institute of Technology*. Prior to the war he was engaged in sales engineering and development work for the *Lithgow Corp.*, and *Cardox Corp.* During the war, Mr. Kahle was a Senior Engineer with the Office of The Chief of Ordnance, Safety & Security Division. Directly before joining The Mitchell-Bradford Chemical Company, he was Technical and

George F. Kahle

Sales Representative for *The Heyden Chemical Corp.*

Mr. Kahle brings to his new position broad technical sales and development experience and has assumed the duties of managing The Mitchell-Bradford Chemical Company's Chicago Office and coordinating the Mid-Western sales and service organization.

Sperry Products to Relocate in Connecticut

Sperry Products, Inc., manufacturers of supersonic and electrical nondestructive testing and measuring instruments, will move its manufacturing plant and general offices from Hoboken, N. J., to Danbury, Conn., during the summer of 1948. A 20-acre site has been acquired and construction of a monitor-type manufacturing building and a three story office building will begin immediately.

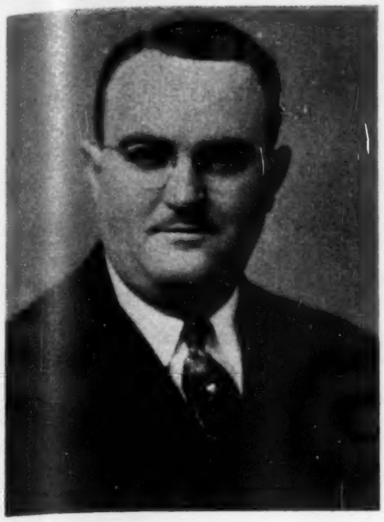
In addition to the testing instruments noted above, Sperry will also manufacture rail detector cars for testing rails in track and hydraulic and mechanical equipment at its new location. Present branch offices in Chicago, Ill., and St. Louis, Mo., will be maintained.

Promotions at Detrex

W. F. Newberry, formerly Industrial Sales Manager, has been appointed Assistant Director of Sales of *Detrex Corporation*, Detroit 32, Michigan, according to an announcement by W. W. Davidson, Vice-President and Director of Sales.

Directly reporting to Mr. Newberry, will be *LeRoy Camel*, the new Sales Manager of the Industrial Products Division, including metal cleaning

W. F. Newberry



LeRoy Camel

equipment and chemicals; *H. S. Tweedy*, Industrial Service Manager; *H. J. Lucey*, Oil-Extraction and Export Sales Manager; and *G. W. Walter*, Advertising and Sales Promotion Manager.

Carbide & Carbon Opens Texas Office

To serve the growing chemical industry in Texas, *Carbide and Carbon Chemicals Corp.* has opened a new sales office at 1527 Esperson Building in Houston. *Paul J. Doyle, Jr.* has been appointed to take charge of the Houston office. Mr. Doyle has been associated with the Corporation since 1940 and has recently returned from service in the Army. He comes to Houston after a brief period at the Corporation's St. Louis office.

NEW BOOKS

Journal of Electrodepositors Technical Society Volume 21, 1945-46

This annual bound volume of the Journal contains a collection of papers and discussions presented before the Electrodepositors Technical Society. The topics are as follows:

The Electrodeposition of Speculum by R. M. Angles, F. V. Jones, J. W. Price, and J. W. Cuthbertson

The Electrodeposition of Tin-Zinc Alloys by R. M. Angles

Electroplating and The Motor Industry by H. Silman

Determination of the Thickness of

Chrome Deposits on Nickel by Drop Tests by E. S. Spencer-Timms

The Tainton Electro-Galvanizing Process for Brylanized Wire by H. Roebuck and A. Brierly

Polishing Methods and Technique by L. Mable

The Surface Condition and Reflectivity of Metals by J. H. Nelson

Health Hazards in the Electroplating Industry by L. B. Bourne

Continuous Electro-Tining of Steel Strip in the Manufacture of Tinplate by C. Frenlel

Electrical Equipment for Continuous Electro-Tinning of Strip by P. F. Grove

Aspects of Finishing Processes to Automobile Engines and Chassis by H. H. Jackson

Body Corrosion Troubles by J. R. Stanfield

A Motorcycle Manufacturers Views on Finish and Protective Coatings by V. Page

Some Impressions of Electroplating in the U. S. A. by A. W. Hothersall

Electropolishing—What is its Status Today by C. L. Faust

Defects in Plating Solutions and Their Remedies by P. Berger

Electroplating on Aluminum by J. P. Gill

The Dyeing of Anodized Aluminum by J. P. Gill

The Electrolytic Polishing of Carbon-Manganese Steels by W. A. Sparks

Copies of the Journal may be obtained from the Hon. Secretary, Electrodepositors Technical Society 27, Islington 77, High St., London N. 1., England—Price: 2 Guineas.

Manufacturers' Literature

Free, valuable information on equipment and processes. Write to the manufacturer and department listed for your copy.

New Plating Barrel Catalog

Hanson-Van Winkle-Munning Co., Matawan, N. J., Dept. MF.

This new catalog covers a wide range of plating barrels, from the small single-unit jewelers apparatus to the large multiple-unit production installation.

Special points of interest are new developments including a pumping apparatus for circulating the solution, the new Merlon cylinders for resistance to a variety of solutions and the new sizes of barrels, with dimensions given for inside measurements as well as styles having outside measurements.

Other features include all types of contacts, triple tie rod hanger, tanks, motor drive, portable and horizontal barrel units, multiple cleaning, plating and rinsing equipment, hoists, hopper units, loading and transfer stands, exhaust arrangements, oblique barrels (single and multiple cylinder units), variable speeds, etc.

Ask for Bulletin PB-107.

Selecting Steam Traps

"Selecting the Right Type of Steam Trap" is the title of a four page, two-color bulletin issued by *Sarco Company, Inc., Dept. MF,* of *Empire State Building, New York* 1, *N. Y.* This bulletin is copyrighted. An illustrated chart permits the reader, at a glance, to select the right type of steam trap for his particular application. The special features, advantages, and recommendations are listed for each type of trap. Large, cross-sectional illustrations make it simple to follow the text.

The company offers to send a free copy to any engineer or production man who actually buys, specifies, or recommends steam traps.

Catalog on Presto Buffs

The Manderscheid Company, Dept. 100, 810 *Fulton Street, Chicago* 7, *Ill.*

Describes a complete line of Bias Type, Loose, Concentric Sewed, Radial Sewed, Spiral Sewed and many other Presto Buffs. Also inclcuded is information on recommended usage, construction details and available sizes.

Copy of Presto Bulletin 106 mailed promptly on request.

Metal Cleaning Solvents

DuBois Co., Dept. MF, Cincinnati 3, *O.*

This company announces the release of a new booklet listing the various Petroleum, Aromatic and Chlorinated Hydrocarbon solvents commonly used in metal cleaning. Tabulated data on flash points, boiling ranges, chemical constitution, toxicity and other important factors make possible easy selection of the correct solvent best suited for a particular job.

This booklet discusses the use of

emulsifiable solvents and the fast growing popularity of emulsion cleaning, and the effect of the various solvent groups on particular soils.

Flash points are also given on each of these solvents mixed with Actusol, an emulsifiable oil detergent manufactured by The DuBois Company. Actusol raises the flash of combustible solvents and provides protection for the skin. Actusol is an emulsifiable oil detergent used to augment the solvent power, emulsify insoluble soils and to provide water rinsability in solvent cleaning operations.

Requests for this four page booklet should be sent to the above address.

Booklet on Injury in Ground Surfaces

A new booklet, published by *Norton Company*, is an up-to-date and complete treatment of the subject "Injury in Ground Surfaces." *Dr. L. P. Tarasov* of the Norton Research Laboratories is the author.

This booklet features many photographs which show clearly the numerous types of defects, such as cracks and burn, that are sometimes found in ground surfaces. Above all, it is written for people concerned with the practical aspects of grinding. Makers of tool steel, tools, dies, and hardened steel parts, are finding the information contained in the booklet to be directly helpful in their everyday work.

In addition, this publication should appeal to metallurgists having to deal with these problems since it presents in detail the latest information on the detection of injury and how to proceed in trouble shooting.

Copies may be obtained by writing to *The Norton Co., Worcester 6, Mass.*

Laboratory Apron

The B. F. Goodrich Co., Dept. MF, Akron, Ohio.

A new lightweight laboratory apron made of Koroseal, its flexible synthetic material, has been added to its line, it is announced by the above firm.

The apron is made of .006 gauge translucent Koroseal film, with cloth tape neck band and tie strings, and hemmed edges. It is 29 inches by 35 inches.

Koroseal, from which the apron is made, has resistance to most chemicals and oils as well as excellent aging characteristics.

Associations and Societies

AMERICAN ELECTROPLATERS' SOCIETY

New York Branch

The annual banquet and technical session of the *New York Chapter* of the *A.E.S.* will be held on Feb. 28th, 1948 at the *Hotel Pennsylvania,* New York City.

The afternoon session will feature prominent speakers who will talk on subjects of general interest to finishing men, and following the technical session the banquet will be held in the evening. A large turnout is expected, and reservations should be made as far in advance as possible with *Mr. Milton Nadel,* 41-15 Fiftieth Ave., Long Island City 4, N. Y.

Twin City Branch

The Twin City Branch of the *American Electroplaters'* Society met on Monday, January 5th, 1948 in the Lodge Room of the Covered Wagon Cafe in Minneapolis, Minn. There were forty-two persons present.

Following dinner, *Al Leonard,* branch president, introduced the following guests; *Messrs. Sam Gendreau* of Minneapolis Honeywell, *Fred Strom* of Reliance Varnish Company, *Austin Frankboner* of Western Electric and *Dean Keller* of Superior Plating & Rustproofing Company.

Following the introduction of guests, the following new members were introduced and welcomed into the Branch: *Mr. Gude Hendrickson* of W. D. Forbes Company, *Mr. Louis Zwick* of Capitol Plating Company, St. Paul, Minn., and *Mr. Paul Hesse* of Union Brass & Metal Mfg. Co., Saint Paul.

The members were glad to see *Mr. Clint Walman* back at the meeting. Mr. Walman was in bed for the past thirteen months and this was his first meeting since before his illness.

Following the business meeting, the meeting was turned over to *Cliff Bowman,* branch librarian, who introduced the speaker for the evening. He was *Dr. Miller,* Technical Director of the Electric Coating Division of the *Harper J. Ransburg Co.* of Indianapolis who spoke on *"Electrostatic Spray-*

COMING A. E. S. EDUCATIONAL SESSIONS AND BANQUETS

DAYTON BRANCH
February 14, 1948 — Miami Hotel, Dayton, Ohio

NEW YORK BRANCH
February 28, 1948 — Hotel Pennsylvania, N. Y. C.

NEWARK BRANCH
March 5, 1948 — Robert Treat Hotel, Newark, N. J.

ROCHESTER BRANCH
April 24, 1948 — Seneca Hotel, Rochester, N. Y.

ing" and "*Detearing.*" Slides were shown in connection with Dr. Miller's paper. Considerable interest was shown by those present, and Dr. Miller was given a vote of thanks by the members for his fine paper.

Dayton Branch

The Dayton Branch of the *American Electroplaters' Society* will hold its Third Annual Educational Session and Dinner Party February 14, 1948 at the Miami Hotel in Dayton. *Mr. Walter E. Moline* of *National Cash Register Co.* and *Mr. Wm. G. Cryderman* of *Hanson-Van Winkle-Munning Co.* are co-chairmen.

Arrangements have been made for the following speakers and topics on the program for the educational session which will start 2:00 P. M.:

Mr. Bernard C. Case of Hanson-Van Winkle-Munning Co. "Electrolytic Purification of Solutions."

Mr. M. C. Welker of American Cyanamid & Chemical Corp. "Demineralized Water in the Plating Room."

Mr. M. L. Moll of Mine Safety Appliances Co. "The Air We Breathe"—A 32 minute film.

The dinner party will start at 6:30 in the evening in the Main Ballroom of the Miami Hotel. Music will be furnished by Earl Holderman's orchestra and another elaborate program of entertainment has been planned. The dinner is $5.00 per plate.

Los Angeles Branch

With 11 past-presidents and *Ernest Lamoreaux*, the branch's only honorary life member of the Supreme Society, as guests of honor, Los Angeles Branch of the AES held a Founders' Night Open House Meeting on the night of Wednesday, January 14.

Marcus Rynkofs, past-president for the 1934-35 term, first secretary and one of the moving spirits in getting the branch organized back in 1929, served as master-of-ceremonies.

Mr. Rynkofs presented a remarkably complete past-history of the branch and read letters and minutes of nearly 20 years ago which gave the younger members a graphic conception of how a small band of 14 electroplating pioneers in the waning years of the Roaring Twenties went about setting up the first AES branch west of the Mississippi. He reviewed the growth of the branch, which in the intervening years has developed into one of the six larg-

est units in the Supreme Society and mothered from among its own membership four other branches—San Francisco, Calif., and Sidney, Adelaide and Melbourne, Aust.

Mr. Rynkofs gave credit to *Frank Rushton,* who retired last year as West Coast manager of Lasalco, Inc., due to illness, as the man who first agitated for the establishment of a Los Angeles Branch in 1928. Somewhat later, he said, a pre-organization meeting was held in the shop of *Don Bedwell's De-luxe Plating Co.*

At this meeting, which preceded the obtaining of a charter from the Supreme Society, *Robert Gripp* of Los Angeles was elected temporary president. Date of the meeting was February 4, 1929, and its location the central YMCA in downtown Los Angeles. One of the charter members brought forth a sigh of reminiscence from the membership when he reported that the cost of a steak dinner that night 19 years ago was 60 cents.

Bob Gripp was subsequently succeeded as temporary president by *Clarence Thornton,* when Bob's business made it necessary for him to move to Pittsburgh, Pa. *Marcus Rynkofs* was the first secretary, *Charlie Russell,* the first librarian. The first board of managers was composed of *Charles Wessells, S. B. Bailey* and *Charles B. Howe.* Initial membership consisted of 24 entirely new members and six transferred from eastern branches. A year later (1931) the membership had grown to 92, and now (1948) has an enrollment of 198, sixth highest of any branch in the AES.

Chairman Rynkofs introduced 11 past-presidents and requested each to present a brief report of the highlights of his administration. Introduced were: *Clarence E. Thornton* (1929-30); *Marcus Rynkofs* (1934-35); *E. R. Williams* (1936-37) *John L. Merigold* (1937-38); *Earl Coffin* (1938-39); *Ray Bray* (1939-40); *Don M. Bedwell* (1940-41 and 1941-42); *Emmette R. Holman* (1942-43 and 1943-44); *Joseph Sunderhaus* (1944-45); *Ed W. Wells* (1945-46); *D. N. Eldred* (1946-47); and the incumbent, *Howard Woodward.*

Newark Branch

The Newark Branch will hold its Spring open educational session on March 5th at the Robert Treat Hotel in Newark, N. J.

It has been the custom in the past to present to the plating industry a very interesting and educational program. The subjects chosen for this session are of great importance to many modern electroplaters today.

The Branch feels honored and privileged to present to you the following well qualified speakers:

Symposium on Barrel Finishing

1. *W. H. Jackson,* The Udylite Corp.
Subject: *Horizontal Plating Barrels and Auxiliary Equipment.*
2. *Dr. George Dubpernel,* United Chromium.
Subject: *Chromium Barrel Plating.*
3. *Kenneth Huston,* Rustless Iron & Steel Corp.
Subject: *Research Program of the A.E.S.*

A discussion period follows each speaker and it is generally acknowledged that the discussion period is very educational and interesting to participants and spectators.

The Newark Branch, host to the 35th American Electroplaters' Convention at Atlantic City, N. J., wishes to extend to its members and friends a cordial

invitation to attend this affair.

AMERICAN SOCIETY OF TOOL ENGINEERS

Names of many firms who have not heretofore displayed their products in a major industrial show appear on the rapidly growing list of exhibitors in the American Society of Tool Engineers' Sixth Industrial Exposition scheduled March 15-19, according to *Harry E. Conrad*, executive secretary of the Society. The Exposition will be held in the Public Auditorium in Cleveland in conjunction with the Sixteenth Annual Convention of ASTE.

Early space sales indicate that this will be the largest and most comprehensive exhibit of new processes, tools and machinery in the history of industry. It is expected that this show will surpass greatly in size the ASTE New Era Exposition of 1946 which drew more than 50,000 invited visitors. Attendance will be restricted to representatives of industry invited by exhibitors and the Society. This limitation is made because it is felt that excluding the general public facilitates the mutually helpful exchange of information and ideas between exhibitors and visitors.

The Convention program will include tours of industrial plants of various types, discussions led by qualified technical men and covering many phases of mass production. A feature event will be a banquet at which an internationally-known industrialist will be the principal speaker.

SOCIETY OF THE PLASTICS INDUSTRY

The Annual Meeting of The Society of the Plastics Industry will be held May 20 and 21, 1948, at Atlantic City, New Jersey, *William T. Cruse*, Executive Vice President of SPI, announced in New York today.

Mr. Cruse stated the Spring meeting will bring the members together for merchandising, technical and business sessions. The headquarters hotel will be the Ambassador, where all sessions will be held. This year the Directors have decided to hold the Conference separately from the National Plastics Exposition to enable the industrial and commercial leaders to concentrate entirely upon the conference meetings.

The Third National Plastics Exposition will be held at Grand Central Palace, New York City, from September 27 to October 2nd, 1948. There may be a few meetings during the Exposition, but the main business sessions of the year for the plastics industry will be in Atlantic City in May.

Chicago Technical Societies Council

On March 22-23-24, 1948, at the Stevens Hotel, Chicago, Ill., the Chicago Technical Conference and Production Show will be conducted simultaneously by the Chicago Technical Societies Council. Paul A. Jenkins, Executive Secretary, 53 West Jackson Boulevard, Chicago 4, Ill., is in charge of arrangements.

21st Exposition of Chemical Industries

Strong evidence of a rapid industrial growth reaching several years ahead was reported by exhibitors at

the 21st Exposition of Chemical Industries. The exposition, closed December 6, after a full week's run in Grand Central Palace, New York City.

Visitors, estimated to number more than 50,000 were impressed and stimulated by the advances disclosed by the exhibits of chemical substances and processing equipment.

At every one of the chemical exhibits new derivatives or new twists in the application of some that have been shown at previous expositions reflect the great activity in laboratories everywhere and the ceaseless search for better and cheaper products. The result is that many exhibitors had long lines of products reaching out in many directions.

At one booth there were displayed samples of 550 chemical substances which have been developed since the last Chemical Industries Exposition. This is the largest number of new items ever brought together in an exhibit of this type, though similar collections have been gathered for a number of previous shows.

More new equipment items fabricated of stainless steel were shown this year than ever before.

Brand new is a line of stainless steel filters for clarification and for the collection of solids, featuring a porous stainless steel filter element. Porous stainless is a new achievement in powder metallurgy.

Stainless steel is coming into ever wider use for processing tanks, heat exchangers, filters, coolers, evaporators, centrifugal dryers, vibrators, valves, pumps, stills, tubing and agitators. One exhibit exclusively devoted to this material included pipe fittings, ladles, pails and barrels, woven wire, slotted screens and baskets, heating elements, as well as bolts and nuts among other items.

Portable and stationary horizontal plate filters of stainless steel were demonstrated. These are for use in the manufacture of chemicals, foods, synthetics and pharmaceuticals. A manufacturer devoted exclusively to the production of corrosion resisting alloys emphasized two new nickel-base alloys, a new line of pumps, a new line of valves, two new heat exchangers and a packaged heat exchanger unit assembly.

A display devoted to lead-lined products included poured homogeneous lead linings on steel, lead-covered copper tubing, and lead prefabricated fittings and flanges.

Several new types of electrostatic collectors were on view, and one exhibitor in this field lists the voltage requirements for the concentration of 90 different materials.

ASTM

A.S.T.M. Committee Week will be held in Washington, D. C., during the week of March 1, 1948.

The following committees, and their

subcommittees, are scheduled to meet:

A-3 on Cast Iron
A-5 on Corrosion of Iron and Steel
A-6 on Magnetic Properties
A-7 on Malleable-iron Castings
A-9 on Ferro-Alloys
A-10 on Iron-Chromium, Iron-Chromium-Nickel and Related Alloys
B-2 on Non-Ferrous Metals and Alloys
B-3 on Corrosion of Non-Ferrous Metals and Alloys
B-5 on Copper and Copper Alloys, Cast and Wrought
B-6 on Die-Cast Metals and Alloys
B-7 on Light Metals and Alloys, Cast and Wrought
B-8 on Electrodeposited Metallic Coatings
C-2 on Magnesium Oxychloride Cements
C-8 on Refractories
C-11 on Gypsum
C-12 on Mortars for Unit Masonry
C-15 on Manufactured Masonry Units
C-16 on Thermal Insulating Materials
C-17 on Asbestos-Cement Products
C-18 on Natural Building Stones
D-1 on Paint, Varnish, Lacquer, and Related Products
D-3 on Gaseous Fuels
D-4 on Road and Paving Materials
D-5 on Coal and Coke
D-8 on Bituminous Waterproofing and Roofing Materials
D-11 on Rubber and Rubber-Like Materials
D-14 on Adhesives
D-18 on Soils for Engineering Purposes
D-19 on Water for Industrial Uses
E-1 on Methods of Testing
E-3 on Chemical Analysis of Metals
E-4 on Metallurgy
E-5 on Fire tests of Materials and Construction
E-6 on Methods of Testing Building Constructions
E-7 on Radiographic Testing
E-9 on Fatigue
A.C.C.—Advisory Committee on Corrosion

Sufficient sleeping rooms to house A.S.T.M. Committee Members attending the meeting have been secured. While the major portion of meetings will be held at the Statler, meeting rooms have been secured in four hotels. The meetings are so arranged that related groups will be in the same hotel.

News from California

By Fred A. Herr

New Location for Los Angeles Branch of United Chromium

Moving of its Los Angeles Offices and Warehouses to 923 *East Third Street, Los Angeles* 13, *Calif.*, has been announced by *United Chromium, Incorporated.* District Manager *R. J. Wooley* asserts this central location will facilitate service on orders for "Unichrome" finishing and maintenance materials, and also technical service on metal finishing problems.

A new company, *International Rectifier Corporation* announces the opening of a plant at 6809 *Victoria Avenue, Los Angeles, California* The new firm is equipped for research and manufacture in the field of colorimetric equipment, photo-electric cells and selenium rectifiers.

Meyer Roter and *James Barker*, partners in the operation of the *Artcraft Plating & Finishing Co.*, 1859 *N. Victory Blvd., Burbank, Calif.*, have

advised us that they have acquired property for a new shop building on Hollywood Way, Burbank, opposite the Lockheed Aircraft Co.

Roter and Barber report that they have plans prepared for a new 25 x 50 foot shop building to be erected there, which will be equipped for plating plastics, silver and gold. In their present shop they specialize in plating ceramics, Lucite, plastic castings and other non-metallic materials. Roter formerly served as foreman of the plating division of the plane over-haul department of Grand Central Air Terminal, Glendale. Barker formerly operated a shop in Burbank for plating baby shoes.

W. A. Felker, president *R. X. Laboratory, Torrance, Calif.*, announces the installation of new solution tank facilities preparatory to the initiation of production on ladies' "diamond dusted" nail files. The Felker process in the production of these files consists of coating the file with diamond dust, then electroplating on top of the dust with a deposit of nickel and chrome. According to Mr. Felker, the process results in a nail file of dual abrasive qualities, for which he anticipates a popular demand. He has installed six 15-gallon solution tanks for nickel, cobalt, copper, tin, chromium and brass.

Edwin R. Calderon and *George W. Slomin* have announced opening of executive offices at 3757 Wilshire Blvd., Los Angeles, from which the affairs of their newly named *Electrochemical Engineering Laboratory* will be conducted. They announced they will provide service as consulting electro-chemists, and in testing, research and investigation in general technical problems for the plating industry of Southern California. *Herbert Dickow* has been named business manager. Laboratory facilities will remain at 4700 *Victoria Ave., Los Angeles.*

A visitor to Los Angeles in January was *G. E. Huenerfauth*, president, *Crown Rheostat & Supply Co., Chicago.* Mr. Huenerfauth spent some two weeks in Los Angeles and the contiguous area, contacting company representatives and clients.

William A. "Bill" Nairne has joined the *A. J. Lynch Company* staff at Los Angeles as a sales engineer, covering the Southern California territory, *Jack Bealle*, director of the firm's plating division, reports.

A. L. Specer, head of the Specer Plating & Polishing Co., Los Angeles, is back on the job after a long period of hospitalization due to a spinal fusion.

Frank Rushton, former west coast manager for *Lasalco, Inc., St. Louis, Mo.*, is confined to the Soldiers' Hospital at Sawtelle, Calif. In January his condition became so aggravated from an attack of Virus X that he was confined to an oxygen tank for nearly two weeks. He had to miss the Founders Meeting of Los Angeles Branch of the AES on the night of January 14, of which branch he was a charter member and one of the chief originators.

Visiting Los Angeles recently for

consultations with regional engineers and executives was *C. P. Doherty*, vice president and general manager of *Dispatch Oven Co., Minneapolis, Minn.*

W. P. Fuller Brawner, vice-president and treasurer of the *W. P. Fuller Co.*, has been elected 1948 president of the San Francisco Chamber of Commerce.

H. D. Easterbrook has been named district manager of a new Southern California district office recently established in Los Angeles by the *Electric Products Co. of Cleveland, O.* The Los Angeles branch is at 1262 South Boyle Ave.

Square Deal Machinery Co., Inc., recently completed an enlargement program which more than doubled its factory area at 8695 *Otis Street, South Gate, Calif. Phillip Greathead*, president, reported that expansion of facilities was dictated by the need for more space for the manufacture of Mercury high production lathes and backstand idlers, the firm having recently taken over the complete line of the former *Mercury Metal Products Co., of Los Angeles*, and for increased production of Square Deal polishing lathes. The firm's 1948 program calls for considerably stepped up production on both lines.

Liberty Plating Co. has awarded contract for the erection of a one-story, masonry addition to its plant at 5745 *Jefferson Blvd., Los Angeles.* The addition is to be erected at the rear of the new plating building completed in 1947, and will contain 15,000 square feet of floor area.

New Construction

New incorporations announced in Southern California since the first of the year in the metal manufacturing, finishing and polishing fields include the following:

Magnetic Inspection & Polishing Co., Inc., incorporated in Los Angeles County for the manufacture, machining, polishing and fabricating of metal items. Associated in the enterprise are *Edwin W. Taylor*, South Pasadena, *C. Johnson*, Monterey Park, and *L. C. Rice, Inglewood.*

Arco Metal Finishing Co., incorporated for $10,000 by *Sidney M. Levine* and *John Adler* of North Hollywood, and *Frank Nordhoff* of Los Angeles.

Rice Engineering Corp., capital stock $100,000, established at Los Angeles by *George M.* and *Harry I. Thompson* and *Joseph H. Grossman* for the manufacture of hinges, doorstops and miscellaneous other hardware items.

Revco Products, capital stock $50,000, incorporated at Whittier, Calif., for the manufacture of all kinds of mechanical appliances, instruments and machines, by *L. M. Stanfield, Harold Richardson* and *M. Hylton*, all of Whittier, Calif.

U. S. Spring & Bumper Co. has completed construction on a new 80x200 foot service, shipping and receiving building at *Downey Road and East Washington Blvd., Los Angeles.* Equipment installed in January consisted of a large Gardner-Denver compressor to supply compressed air at 650 cubic feet per minute to the entire plant. Also installed were new furnaces for drawing steel and aluminum, which reportedly are intended for use to draw all springs manufactured in the new structure. A 10,000 gallon oil storage tank has been installed in the rear to supply oil for the continuous motion quenching tank.